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SCIENCE ABSTRACTS

SECTION A.—PHYSICS.

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By using compressed air at about 25 lbs. pressure it is possible to work the two mercury pumps employed without using any rubber tubing. There are no stopcocks through which the mercury has to pass, and the mercury remains clear; the only stopcock in the whole apparatus is that between the drying bulb and the radium bulb, and this has caused no trouble. The first Toepler pump draws the impure radon through purifying apparatus into a bulb. The second pump draws it into a tube connected with the jacket of a Dewar flask. Liquid air is poured into the flask and the residual uncondensed gases are pumped off by pump 2. The liquid air is removed and the radon pumped off and collected over mercury. H. N. A.

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2885. Comparison of Compressibilities of Gases. C. G. Addingley and R. Whytlaw-Gray. *Faraday Soc., Trans.* 24. *pp.* 378–387, *July*, 1928.

A description is given of a differential apparatus for comparing the compressibilities of gases instead of measuring them in the ordinary way. The chief advantages of the method are its compactness, rendering temperature control easy, the elimination of constant errors, and increased accuracy of volume measurement due to making correction for variation of dead space volume with meniscus height. The ratio of the compressibility coefficients of hydrogen and oxygen was measured and found to be $(1 + \lambda)O_2/(1 + \lambda)H_2 = 1{\cdot}00148$. J. J. S.

2886. Limits of Elastic Energy. G. Krall. *Accad. Lincei, Atti*, 7. *pp.* 223–228, *Feb.* 5, 1928.

A mathematical paper on certain problems of elasticity. J. J. S.

2887. Photographic and Kinematographic Study of Photo-elasticity. Z. Tuzi. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 8. *pp.* 247–267, *June*, 20, 1928.

For measuring the difference between the two principal stresses by means of polarised light the so-called compensator method has many drawbacks, prominent among which are personal errors and stress-optical after-effect [see Abstract 517 (1928)]. The present author now proposes its replacement by a photographic method. Since colour fringes become ambiguous when photographed, they must be monochromatic, and for the purpose a U-tube mercury-arc lamp has been used, the green line 5461 Å. being separated by means of a green filter. In order to plot a curve directly from a negative, the specimen must be optically sensitive enough to reveal many fringes within its elastic limits, and phenolite was found to be the most sensitive material for this purpose. The paper, which is very well ilustrated, discusses the kinematographic method and considers in detail the stress distribution of an angle plate under compression. H. H. Ho.

2888. General Theories of Strain and Elasticity. C. Sunatani. *Tohoku Univ. Technol. Reports*, 7. *pp.* 27–67, 1928.

Mathematical. The ordinarily accepted theory of strain is only true for infinitesimal strain; the geometry of finite strain is considered. W. G. B.

2889. Vibration Periods of Frames. W. Prager. *Zeits. f. tech. Phys.* 9. 6. *pp.* 223–227, 1928.

The periods of the free vibrations of a frame consisting of two columns firmly fixed at their bases, with a cross beam at the top, having rigid corners, and of combinations of such, are calculated. The results are of importance when such frameworks are used to support machinery, and it would seem that in general the speed of a machine is between the two gravest frequencies. W. G. B.

2890. Lines of Principal Stress in an Infinite Perforated Plate under Tension. I. Nakayama. *Imp. Acad. Tokyo, Proc.* 4. *pp.* 259–262, *June*, 1928.

As an instance of the general formulæ worked out by the author in a previous paper, graphs are given showing isoclinic lines and "contour" lines for the principal stresses, and their difference and ratio round an elliptic hole in an infinite tension member. W. G. B.

2891. Experimental Study of the Ritz Theory of Transverse Vibrations of Square Plates. Alice Lemke. *Ann. d. Physik*, 86. 5. *pp.* 717–750, *July* 28, 1928.

Tables from which the coefficients of the series and the period-equation can be calculated are given for several values of Poisson's ratio, 10 terms of the series being used. Two cases are also given, using 6 and 15 terms, to show what may be expected of the approximation to 10. Agreement with experiment, both as regards frequency and nodal lines, was good for the graver tones. W. G. B.

2892. Distribution of Stress Round a Circular Hole in a Plate. W. G. Bickley. *Roy. Soc., Phil. Trans.* 227. *pp.* 383–415, *July* 2, 1928.

This mathematical paper is an examination of the stresses round a circular hole in an otherwise infinite elastic plate of uniform thickness, due to prescribed tractions in the plane of the plate acting on the circular boundary. A general solution is obtained and particular cases are examined in detail, these cases being chosen to combine, as far as possible, mathematical simplicity with some semblance of the type of distribution of traction likely to occur in practice. The analysis is applied to some selected experimental results. [See also Abstract 197 (1921).] H. H. Ho.

2893. Periods of a Free-Free Bar Immersed in Water. E. B. Moullin and A. D. Browne. *Cambridge Phil. Soc., Proc.* 24. *pp.* 400–413, *July*, 1928.

The object of the experiments was to determine the virtual mass of a free-free bar vibrating naturally under water with two or three nodes. The value calculated from the measured natural frequencies in air and in water is compared with that deduced mathematically for a long elliptic cylinder moving broadside on through an infinite and non-viscous fluid. It is shown that it is possible to calculate very accurately the frequency of a long uniform submerged bar of any rectangular cross-section. Experiments with partially immersed rectangular bars and with a light racing eight are also described. W. S. S.

2894. Damping of Mercury Ripples. J. J. Manley. *Phys. Soc., Proc.* 40. *pp.* 178–180, *June*, 1928.

The ripples formed upon the surfaces of the mercury columns of an interferometer pressure gauge are eliminated by floating upon the surfaces thin discs of glass. A. A. D.

2895. Measurement of Interfacial Tension of Liquid-Liquid Systems. F. E. Bartell and F. L. Miller. *Am. Chem. Soc., J.* 50. *pp.* 1961–1967, *July*, 1928.

In order to measure the interfacial tension between water and crude petroleum oils, some of which were practically black so that the usual methods were not satisfactory, the authors have devised two pieces of apparatus in both of which two vessels, one containing water, are joined by a vertical capillary tube, which in one of the instruments forms part of a U-tube joining the bottoms of the two vessels. The oil is passed drop by drop into the second vessel, and drives the oil-water meniscus to a definite mark on the capillary tube. The heights of the free surfaces of the oil and water above the level of the meniscus are measured, and from these the interfacial tension is calculated. For work of ordinary accuracy it is shown that no capillary corrections are necessary. H. N. A.

2896. Viscometry of Lubricating Oils. Parts I and II. W. Ostwald and A. Föhre. *Kolloid Zeits.* 45. *pp.* 166–177, *June, and pp.* 266–279, *July,* 1928.

Part I deals with the viscometry of lubricating oils at variable velocities and pressures ranging between 7·5 and 103·0 cm. H_2O. With slight deviations at the lowest pressures, 17 different mineral lubricating oils give viscosities which are appreciably greater and less than that of glycerine, based on the Hagen-Poiseuille law at 25° and under the same apparatus conditions for which this law is valid. Only a minimum of structure viscosity is present, and in the temperature effect Voltol oil has a smaller coefficient than the others. Schwedhelm's expression, $z/G = (z'/G)^{H(t'-t)}$, where z and z' are the viscosities at temperatures t and t', and G and H instrument and characteristic constants, is found to fit the experimental data best. Part II investigates the effect of mechanical treatment—*e.g.*, prolonged automatic stirring—on the viscosity of lubricating oils, considerable changes being produced which vary with the time. Addition of acids such as acetic acid generally lowers the viscosity, whilst even small amounts of caustic alkalis (alcoholic potash or soda, but not ammonia) have the contrary effect, *viz.*, an appreciable rise. Small additions of highly dispersed graphite and talcum, or Marseilles soap or lanolin, raise the viscosity, although Voltol oil is an exception in having its viscosity lowered by soap. The viscosity curves of oils to which additions have been made are so individually characteristic of each oil as to constitute a ready means of recognition. H. H. Ho.

2897. Relative Motion of a Liquid Filling a Rotating Vessel. B. Meisel. *Comptes Rendus,* 186. *pp.* 1423–1425, *May* 21, 1928.

In the case of an incompressible liquid which fills completely a vessel rotating about a fixed axis, it is established that the relative motion of the liquid is invariant for all parallel axes of rotation, *i.e.*, that the displacement of the vector of angular rotation does not change the relative motion of the liquid. H. H. Ho.

2898. Determination of the Profile of a Circular Wave of Small Amplitude on the Surface of a Liquid. J. Baurand. *Comptes Rendus,* 186. *pp.* 1822–1823, *June* 25, 1928.

Although the profile of a large rectilinear wave at the surface of a liquid can be determined by direct photography of the capillary meniscus formed by the liquid in contact with a vertical glass surface, this method is not applicable either to circular waves or to waves of small amplitude. In the latter cases the profile must be determined by points whose displacements are photographed as functions of the time, and the present paper contains the detailed description of an experimental method devised for the purpose. H. H. Ho.

2899. Characteristics of a Karman Vortex Street in a Channel of Finite Breadth. H. Glauert. *Roy. Soc., Proc.* 120. *pp.* 34–46, *Aug* 1, 1928.

Starting from Karman's theory of the "vortex street," formed of a succession of independent vortices passing down-stream behind a bluff body, placed in a stream of infinite breadth, the author studies the case where the breadth of the stream is finite. He introduces an infinite series of images of the vortex street in the walls of the channel in order to represent the boundary conditions on the walls; the constraint experienced

by the vortex street can be estimated as the velocity field of this series of images. An equation is obtained for the total drag and one for the drag coefficient. The conditions close to the body itself are then considered, and the rate of generation of vorticity, R, is discussed. On certain assumptions $R = V^2$, which appears to be correct for a bluff obstacle but not for one of elongated shape. The equations obtained are compared, in the case of a flat plate, with the experimental results of Fage for different values of the ratio between the width of the channel and that of the body; the agreement is satisfactory. H. N. A.

2900. Contributions to the Study of Copper Alloys by X-Ray Diffraction. J. Loiseau. *Comptes Rendus*, 186. *pp.* 1732–1733, *June* 18, 1928.

Cold-working orientates the 100 planes to a direction 5° 30′ with the plane containing the direction of rolling and the perpendicular axis of the plate. The metal suffers a profound modification due to deformations by gliding. Reheating has the effect of orientating the 100 planes round an axis perpendicular to the plate. Heating through a transformation temperature destroys the effect of rolling. After long heating a single crystal may be obtained. J. E.

2901. Crystallographic X-Ray Study of Simultaneous Electrolytic Deposits of Two Metals. A. Roux and J. Cournot. *Comptes Rendus*, 186. *pp.* 1733–1736, *June* 18, 1928.

Examination of the X-ray diagrams shows that the deposits are solutions or combinations of the two metals, and not merely mixtures. J. E.

2902. Allotropic Modification of Silver. G. Allard. *Comptes Rendus*, 187. *pp.* 223–225, *July* 23, 1928.

Silver forms cubic crystals when prepared by sublimation at a high temperature or found native. When silver was studied by means of X-rays the structure was found to be cubic, the side of the cube being $4{\cdot}06 \cdot 10^{-8}$ cm. The study of silver, obtained by the action of copper on silver nitrate solution, by the method used for powdered materials, gave results which were incompatible with cubic structure, and could only be explained by the allotropy of silver. The allotropic modification of silver is orthorhombic. The constants of the crystal were measured.

F. J. B.

2903. Fibrous Structure in Metals Deposited by the Difference of Electrolytic Solutional Pressures. S. Tsuboi. *Kyoto Coll. Sci., Mem.* 11. *pp.* 271–277, *July*, 1928.

Metallic silver deposited by a solution of silver nitrate by putting a small piece of copper into it has a fibrous structure the common axis of which is 110 and makes an angle of 30° with the direction of the deposited siver. The micro-crystals show a rotation about this axis with an angle of some $\pm$ 11°. As the (111) planes of the silver-crystal lie roughly parallel to the flat surfaces of the deposited metal, the direction of the growth of the deposited silver lies nearly parallel to the (112) axis.

AUTHOR.

2904. Strength of Crystals of an Aluminium Alloy. R. Karnop and G. Sachs. *Zeits. f. Phys.* 49. 7–8. *pp.* 480–497, 1928.

Monocrystals of an alloy with 5 % Cu were prepared by stretching a

wire 1·5 % and heating to 525° for six days. They could be " improved " by quenching from 525° and then heating to 100°. This raised the shearing force at the elastic limit from about 2 to 9·5 kg./mm.^{2} and the breaking strength from 20 or 25 kg./mm.^{2} to 40 or 50 kg./mm.^{2}; the amount of stretching was only slightly altered; the Laue diagram remained nearly the same when the crystal was " improved." The distortions of the improved crystals took place in a manner very similar to those of aluminium monocrystals, and the active shearing force in the slip plane was about 9·3 kg./mm.^{2}, though there were variations of $\pm$ 8 %. The recrystallisation of broken, improved rods took place as in the case of aluminium crystals at very high temperatures, and comparatively large crystals were formed. With unimproved crystals which had undergone a different heat treatment originally, a fine-grained crystal structure was produced when the broken rods were heated to a temperature 100° lower than that required for the recrystallisation of the improved rods. The difference seems to be due to the separated impurities, which have a greater disturbing effect in the unimproved than in the improved crystals. H. N. A.

2905. Transformations of Lattice Structure in Metallic Mixture Crystals. G. Borelius, C. H. Johansson and J. O. Linde. *Ann. d. Physik*, 86. 2. *pp.* 291–318, *June* 15, 1928.

It has previously been shown that, near the proportions corresponding to Cu_3 Au, Cu Au, Cu_3 Pd and Cu Pd, an ordered distribution of the atoms is stable at low temperatures and a statistically unordered one at high temperatures. The relations are well shown by means of resistance temperature diagrams, in which the points of transformation appear clearly; in all cases distinct temperature hysteresis appears in the region in which transformation of the lattice arrangement takes place. The differences between the curves obtained for or near the above proportions are considered in the light of the X-ray data. The thermodynamical relations governing the transformations are considered, and it is shown that the temperature hysteresis can be dealt with on a thermodynamical basis. Further measurements of the free energy of mixture crystals, and on the influence of high pressure on the transformation, are necessary for a complete explanaton. H. N. A.

2906. Crystal Structure of Tetra-Ethyl Ammonium Iodide. I. Nitta. *Imp. Acad. Tokyo, Proc.* 4. *pp.* 292–295, *June*, 1928.

From Laue photographs it is concluded that tetra-ethyl ammonium iodide is tetragonal dispheroidal $a : c = 1 : 0{\cdot}783$. The unit cell containing two molecules of $N(C_2H_5)_4I$ has edges given by $a = 8{\cdot}85$ Å. and $c = 6{\cdot}93$ Å. The space group is S_4^2. It is concluded that the valency forces of the ammonium N atom are approximately tetrahedral. Various speculations on the structure are discussed. In the Laue photograph normal to (001) a slight dissymmetry in the intensity distribution of the spots was observed as in the similar photograph for penta-erythritol. W. H. Ge.

2907. Crystal Structure of β-Manganese. G. D. Preston. *Phil. Mag.* 5. *pp.* 1207–1225, *June*, 1928.

The β-modification of manganese stable above 742° C. was examined at room temperatures, the specimens being obtained by annealing at 975° C. with subsequent quenching in water. Crushing the aggregates in an agate mortar was found to deform the crystals, and the specimens used were

obtained by etching small pieces of the quenched metal in dilute hydrochloric acid. No single crystal was obtained, but the Laue and oscillation methods could be used. The unit cell containing 20 atoms has an edge of 6·29 Å. and belongs to the cubic system 0^7 (or 0^6). These two groups are enantiomorphous and indistinguishable by X-ray methods, but a study of the observed intensities of reflexion showed that no other groups are possible for β-manganese. W. H. Ge.

2908. Optically Active Uniaxial Crystals. G. Friedel. *Comptes Rendus*, 186. *pp.* 1788–1790, *June* 25, 1928.

A note on W. G. Burgers' recent paper [see Abstract 540 (1928)]; according to Burgers, twinning is due to an essential pseudosymmetry of the crystalline structure, but as a matter of fact this is not the case, and twinning in no way depends on the symmetry or pseudosymmetry of the structure or of the groups of atoms of which it is built up. The stability of a crystalline structure does not necessarily demand that it should be periodic or quasiperiodic throughout; the periodicity may be interrupted, and the structure may be built up of different homogeneous portions or twins. According to the correct theory the period of the lattice common to two twin crystals is a multiple of the simple period, while according to Burgers it is a submultiple. H. N. A.

2909. Study of Chlorites by X-Rays. C. Mauguin. *Comptes Rendus*, 186. *pp.* 1852–1855, *June* 25, 1928.

The author has already shown that all the different micas have similar structures whose unit cell contains 12 atoms of oxygen or fluorine [see Abstracts 2589 and 2590 (1928)]. Some chlorites have been subjected to a similar examination. It is found that they are, like the micas, built up in layers whose thicknesses are much alike in different types and equal to about one and a half that of the mica sheets (*i.e.*, about 14×10^{-8} cm.). Each layer is formed by the repetition of a group of atoms in an equilateral triangular network of side $3{\cdot}07 \times 10^{-8}$ cm. (cf., biotite). There certainly exists a very close relation among these minerals. The layers in chlorites are piled in such a way as to permit the repetition of a very thin rhombhedron ($a = 3{\cdot}07 \times 10^{-8}$ cm. $c = 42 \times 10^{-8}$ cm.). Laue photographs show a trigonal symmetry. The unit cell contains 6 atoms of oxygen. No chemical formula can represent a molecule of these chlorites with any reality. (An added note points out that the number of hydrogen atoms in the above cell comes out at 8/3, indicating that this cell is really one-third of the true unit.) J. E.

2910. Plastic Deformation of Crystals. R. v. Mises. *Zeits. f. angew. Math. u. Mechanik*, 8. *pp.* 161–185, *June*, 1928.

A general theoretical survey of the mechanism of plastic deformation of crystals. W. H. Ge.

2911. Atomic Structure Factor Curves in the Crystal Reflection of X-Rays. G. E. M. Jauncey and W. D. Claus. *Phys. Rev.* 32. *pp.* 12–21, *July*, 1928.

Refers to the authors' previous paper [see Abstract 2256 (1928)] in which they showed that for certain values of D the grating space of a rocksalt crystal, the area under a U-curve for Cl rose above 19 electrons. The point is further discussed, and it is proved that for a symmetrical

atom the F values calculated according to the classical theory, unmodified for the Compton effect, but multiplied by the Debye temperature factor, give U-curves the areas under which never exceed the number of electrons assumed in the model. An unsymmetrical atom also gives F values which behave in the same way. However, both experimental F values and calculated ones, modified to take into account the Compton effect, give U-curves which indicate more than the true number of electrons for certain values of D, so that it appears as if the Compton effect is involved in the process. If this is true, the use of the Fourier analysis method, as now applied, is invalidated. It is shown that the U-curve can be obtained by means of the Fourier integral $U(r) = 8\pi r \int_0^\infty xF(\lambda x/2) \sin 2\pi rx dx$. H. N. A.

2912. Failure of the X-Ray Method of Determining the Crystal Lattice. C. Mauguin. *Comptes Rendus*, 187. *pp.* 303–304, *July* 30, 1928.

Friedel has recently stated that the X-ray method does not always give the correct lattice. The author treats biotite and the chlorites. The dimensions of the diagonals of the elementary rhombus on which the lattice of ordinary micas is built up are 9·21 Å. and 5·32 Å., while in the case of biotite they are 5·32 Å. and 3·07 Å., the area of the rhombus is one-third of that of the other, and there are four O atoms in the unit cell. For the chlorites the dimensions are the same as for biotite, but this gives $2\frac{2}{3}$ atoms of H per unit cell. It seems necessary to assume that the true unit cell of the chlorites is at least three times as large as that given experimentally, and it is probable that this is also true for biotite. Certain facts observed in the X-ray photographs are taken as confirming this view. A scheme is proposed, based on hexagonal cells, in which the O atoms are situated in exactly the same way, while the electropositive atoms have three distinct arrangements in the cells. The result of X-ray examination will depend on the manner in which the three sets of cells are arranged.

H. N. A.

2913. Motion of a Particle in a Periodic Field of Force. S. L. Malurkar and J. Hargreaves. *Cambridge Phil. Soc., Proc.* 24. *pp.* 447–450, *July*, 1928.

In the electron theory of metals, if the nuclei are fixed and regularly spaced, the electrons will move in a field the potential of which is periodic. The problem is treated by means of wave mechanics, the electron being regarded as a packet of elementary de Broglie waves moving coherently. The expression obtained, which gives the points at which the electron will most probably be found, is almost the same as the classical one. If the periodic field is not too large the electron moves as a whole with slight periodic fluctuations of its velocity. H. N. A.

2914. Grouping of the Atoms. (Miss) C. Chamié. *Comptes Rendus*, 185. *pp.* 1277–1279, *Dec.* 5, 1927.

See also Abstract 2556 (1927).

2915. Fermi Statistical Postulate; Examination of the Evidence in its Favour. E. H. Hall. *Nat. Acad. Sci., Proc.* 14. *pp.* 366–370, *May*, 1928.

The discussion is based on extracts drawn from the papers by Fermi,

Dirac, Sommerfeld, Pauli and Heisenberg. It is considered that as Einstein has given a statistical treatment of the ideal gas problem which meets the mathematical requirements of the case, independently of Fermi's hypothesis, the acceptance of the latter must depend on its success in applications to the electron theory of metals. W. S. S.

2916. Generalisation and Solution of Dirac's Statistical Equation. V. Fock. *Zeits. f. Phys.* **49. 5–6. *pp.* 339–357, 1928.**

The statistical problem of the distribution of states in a totality (*Gesamtheit*) of mechanical systems dealt with by Dirac in his paper, " Emission and Absorption of Radiation " [see Abstract 2042 (1927)], is generalised, and a general solution is obtained by means of a generating function which satisfies the wave equation in the Hilbert space.

H. N. A.

2917. Wave Mechanics of the Atomic Lattice. M. J. O. Strutt. *Ann. d. Physik*, **86. 2. *pp.* 319–324, *June* 15, 1928.**

Deals with the movements of the electrons in a one, a two and a three-dimensional lattice by means of wave mechanics. A purely sine form distribution of the potential is assumed. The characteristic value spectra can be obtained by means of the theory of Mathieu's differential equation. The spectrum is continuous for negative and small positive values of E; for increasing values of E it constantly becomes more discrete. It appears possible by means of the results obtained to obtain an explanation of some of the phenomena of metallic conductivity, particularly of superconductivity. H. N. A.

2918. Wave Mechanics of an Atom with a Non-Coulomb Central Field. Part III. Term Values and Intensities in Series in Optical Spectra. D. R. Hartree. *Cambridge Phil. Soc., Proc.* **24. *pp.* 426–437, *July*, 1928.**

Continuing on the lines of previous work [see Abstract 1170 (1928)], the extended Ritz series formula is derived together with the law $I/\nu^4 \propto 1/n^3$ for the variation of intensity I in a series with the effective quantum number n of the variable term. W. S. S.

2919. Dirac's Theory of the Electron. G. Breit. *Nat. Acad. Sci., Proc.* **14. *pp.* 553–559, *July*, 1928.**

The matrix operators α_1, α_2, α_3 occurring in Dirac's wave equation for the electron are shown to correspond to the components of the velocity vector, $\dot{x}/c$, $\dot{y}/c$, $\dot{z}/c$ in the same sense as Pauli's s_x, s_y, s_z represent the spin of the electron in the latter's formulation of the theory of the rotating electron [see Abstract 2671 (1927)]. It is suggested that a fourth premise be added to the three stated explicitly by Dirac, namely, that the characteristic values of $\dot{x}/c$, $\dot{y}/c$, $\dot{z}/c$, $\sqrt{1-\beta^2}$ are ± 1. This amounts to assuming the only possible velocity of an electron to be that of light, a finite velocity corresponding to the statistical superposition of $+c$ and $-c$. W. S. S.

2920. Pauli's Exclusion Principle. H. D. Ursell. *Cambridge Phil. Soc., Proc.* **24. *pp.* 445–446, *July*, 1928.**

A simple explanation of Pauli's principle was first given with the wave mechanics, its interpretation being that the wave functions of Schrödinger were antisymmetrical in all the electrons concerned, and this

necessitates a theory of "non-combining states." Hund has applied the latter theory to explain various atomic and molecular properties, and it forms the basis of the new statistical mechanics [see Abstract 900 (1927)]. The usual proof of the existence of non-combining states, however, involves considerably more than the usual expansion theorem and requires the result that any wave-function may be expressed as a sum of "symmetrical normal forms." Since this theorem does not seem to have been proved the author gives a deduction of the exclusion principle which avoids its use, and also appends a proof of the expansion theorem used implicitly in previous treatments and intended as a commentary on Hund's work.

H. H. Ho.

2921. Analytical Apparatus of Quantum Mechanics. A. Wintner. *Zeits. f. Phys.* 49. 9–10, *pp.* 674–696, 1928.

The writer deals with the mathematical conception of the frequency condition or the "metaphorical" energy theorem in the case of a continuous spectrum in the Heisenberg mechanics. W. S. S.

2922. Magneto-Electron Theory of Gravitation. C. Snow. *Washington Acad. Sci., J.* 17. *pp.* 457–464, *Nov.* 4, 1927.

The consequences are worked out of a unified theory of gravitation and electricity originating in the discovery that in a world governed by the Lorentz theory which neglects gravitation, a replacement of every electric density ρ by $\rho \cos \alpha$ and the introduction of a magnetic density $\rho \sin \alpha$, where α is an arbitrary constant, would produce no detectable change [see Abstract 996 (1928)]. The constant α is chosen to satisfy $\tan \alpha = \frac{m}{e}\gamma^{\frac{1}{2}}$, where γ is the gravitational constant and m and e are the mass and charge of an electron. The complete vector field E_0H_0 of the Maxwell-Lorentz equations is resolved into two fields, $E_0 = E + e$ and $H_0 = H + h$, where E, H satisfy the Maxwell-Lorentz equations when cognisance only of the electric density $\rho \cos \alpha$ is taken, and e, h satisfy when cognisance only of the magnetic density is taken. The force between two bodies is then shown to be made up of two terms, one representing the ordinary electromagnetic force, the other (due to the magnetic density) corresponding to the gravitational attraction. The theory is extended in tensor form to include the case when space-time is not flat. W. S. S.

2923. Gravitational Field of an Ideal Fluid. J. Ghosh. *Calcutta Math. Soc., Bull.* 19. *pp.* 67–82, *June*, 1928.

The gravitational field of a mass of fluid in which pressure and density are equal at every point is investigated, the field equations being assumed to have either the original form or to contain the cosmological constant. The solutions reduce to the Galilean and the de Sitter forms respectively when the energy tensor vanishes. Schwarzschild's solution for the field of an incompressible liquid sphere in flat space is shown to represent really the field of an ideal gas in the naturally curved world.

J. S. G. T.

2924. Experimental Evidence Supporting the Kinetic Theory of Gravitation. C. F. Brush. *Frank. Inst., J.* 206. *pp.* 143–150, *Aug.*, 1928.

The author in 1911 formulated a kinetic theory of gravitation according

to which the energy acquired by falling bodies is derived from the ether. Certain bodies would possess the power of absorbing gravitational waves by a fortuitous resonance phenomenon, and remain permanently warmer than their immediate surroundings. The author finds this to be particularly the case with complex silicates, and more especially with a complex silicate of the protoxides of nickel and cobalt. Consistent with this result, it is found that the velocity of fall of a container filled with this silicate is always less accelerated than that of a similar container filled with lead sawdust. This reduced acceleration is shown by all substances exhibiting the thermal phenomenon referred to. Radioactive substances are excluded. The observed difference of times of fall is of the order 1/400,000 sec. J. S. G. T.

2925. Closed Riemann Spaces admitting a Continuous Transitive Group of Displacements. E. Cartan. *Comptes Rendus*, 186. *pp.* 1817–1819, *June* 25, 1928.

The method recently developed in a paper on complete orthogonal systems of functions in certain Riemann spaces (*loc. cit.*, pp. 1594–1597) is now extended to every closed Riemann space (wherever metrically regular) which permits a continuous transitive group of displacements. The paper is entirely mathematical and should be consulted in its entirety. H. H. Ho.

2926. Radiation and Relativity. Part I. G. Y. Rainich. *Nat. Acad Sci., Proc.* 14. *pp.* 484–488, *June* 15, 1928.

This paper contains a systematic study from the relativity viewpoint of a particle moving with the velocity of light, the methods by which a material particle is studied being followed and the standpoint of special relativity adopted. The field of a material particle can be obtained if to the general field equations the condition be adjoined that the field must possess the symmetry properties of a geometrical point. Guided by this analogy a field is sought possessing the same symmetry as the configuration representing the photon, *i.e.*, a field which is transformed into itself by all Lorentz transformations which do not affect a vector 1, 0, 0, 1 and a straight line of that direction through the origin. The following remarks are made: If time and space be separated, the field moves together with the photon remaining unchanged; a plane singularity accompanies the photon, *viz.*, the plane which contains the photon and is perpendicular to the direction of its motion is a singular plane of the field and appears to play the rôle of a wave front; there is no periodicity of the field; the latter is not self-conjugate, since the electric and magnetic vectors are not at right angles and of equal length, although this condition is approached asymptotically. H. H. Ho.

METEOROLOGY AND GEOPHYSICS.

2927. Root Problem of Macro - Meteorology. F. Baur. *Monthly Weather Rev.* 56. *pp.* 180-185, *May*, 1928.

The author investigated the possible dependence of the general circulation of the atmosphere on (1) changes occurring within the atmosphere itself and (2) extraterrestrial phenomena. No connection with cosmic influences such as sunspots, faculæ, protuberances, changing form of corona or solar contrast could be proved. Foregoing temperature and

pressure abnormalities on the earth do, however, affect this circulation. Also, possible periodic variations in solar radiation have a greater influence on terrestrial weather conditions only when they find a resonance in the complex system of the general circulation of the air. R. S. R.

2928. Influence of Arctic Ice on the Subsequent Distribution of Pressure over the Eastern North Atlantic and Western Europe. C. E. P. Brooks and Winifred A. Quennell. *Meteorolog. Office, Geophys. Mem.* 5. *No.* 41. [41 *pp.*], 1928.

An investigation of the long-standing belief that Arctic ice has a considerable effect on the general pressure distribution and, therefore, on the weather, in the neighbourhood of the British Isles. The ice-areas included are, in the first place, those off Iceland and in the Greenland Sea, Barents Sea and Kara Sea; and secondly, the Newfoundland Banks. It is found that when there is much ice in spring in the first or strictly Arctic groups of areas, pressure at the time tends to be above normal near Iceland and below normal near the Azores, so that springs in which there is much Arctic ice tend to have more frequent and stronger easterly winds, and less frequent and weaker westerly winds than usual. In the following late autumn and winter (November to January) weather tends to be unusually stormy in the British Isles, with pressure below normal over Ireland, England, France and the Azores, but above normal to the north of Iceland and over the north of Norway. Similar conditions, both easterly winds in spring and stormy weather in the late autumn, tend to recur in the following year. The effect of ice off Newfoundland on the subsequent pressure distribution is not so well marked as the effect of Arctic ice in the narrow sense, but there is a slight tendency for many icebergs in April to June to be followed by low pressure over the British Isles and northern Germany in January to March, nine months later. AUTHORS.

2929. Eddy Viscosity and Skin Friction in the Dynamics of Winds and Ocean-Currents. V. W. Ekman. *Roy. Meteorolog. Soc., Mem.* 2. *pp.* 161–172, *May*, 1928.

The author reviews first the expressions given by H. Solberg for the variation of wind speed and velocity with height and finds them in disagreement with pilot balloon results. Expressions are then obtained for the variations of these quantities under certain assumptions regarding the change of the coefficient of viscosity with height. The expressions are probably true if the laws of motion of the upper air hold down to 6 m. above land and 1 m. above sea. The results agree also with the changes of the deviation of wind direction for different latitudes. It is finally shown that by taking the motion of the sea and the air above it the velocity curve has three separate spirals occupying the lower part of the air, the surface layer of water and the bottom layer of water respectively. Corresponding to these there are three different depths of frictional influence which are proportional to three virtual kinematical coefficients of viscosity. R. S. R.

2930. Gustiness of Winds. T. Terada, M. Tamano and K. Nisida. *Tokyo Univ. Aeronaut. Research Inst., Report, No.* 38. *pp.* 235–270, *June*, 1928.

The records of a Dines anemograph exposed at Tokyo for nearly six years were used. The gustiness g was taken as the ratio of the amplitude a

of the wind velocity to the mean velocity V in each successive quarter of an hour. The g — V curves were obtained for the 16 wind directions, for each month, for day and night, and the frequency distribution of values of g examined for different values of V. The difference in the g — V relation according to season is explained by the difference in solar radiation and the differences for day and night are discussed. The relation between g and the direction angle θ of the wind is examined and compared with a topographical factor, R, depending on the roughness of the ground. To explain the results the vertical distribution of the resultant horizontal vorticity of the atmosphere for different seasons is examined and its seasonal variation is found to be similar to that for g. The results of wind channel tests on the gustiness produced by a ridge are given. It is concluded that gustiness of winds is due to mechanical and thermal factors. For the former there is vorticity due to (i) the stratified structure of wind layers in the lower atmosphere and (ii) the local topography, and for the latter there is (iii) convection due to the solar radiation and (iv) the influence of the variation in the stability of the lower atmosphere due to the solar radiation and the nightly cooling upon the mechanical effects enumerated in (i) and (ii). R. S. R.

2931. Forecasting Cyclones in the Antilles Sea and the Gulf of Mexico. C. Laforest-Duclos. *Comptes Rendus*, 187. *pp.* 17–19, *July* 2, 1928. *Extract.*

The author considers that three factors acting over the globe produce all the main changes. These are solar heating and the attractions of the sun and moon. From a detailed survey of the current crossing the Atlantic near the equator and moving along the north coast of South America to the Gulf of Mexico, he considers that the air moves into a region of maximum vapour concentration and a place where depressions very frequently originate. He deduces a formula $f = chr\psi/[0{\cdot}44 + (\gamma - l)]$, where c is the temperature of the current deduced from the sun's declination, h a coefficient of the oceanic tide, r the cooling due to the sun's position, ψ the variation in 24 hours of the declination of the axis of attraction, γ the declination of this axis, and l the latitude of the point on the American coast determined by the system of meridional zones. f is calculated daily and represents the strength or tendency of the cyclone. If it exceeds a certain value a cyclone results. Application of the method to American Weather Bureau charts for 1922–23 gave a large measure of success.

R. S. R.

2932. Temperature Changes in the Baltic Sea. H. Mäe. *Akad. Wiss. Wien, Ber.* 137. 2*a*. *No.* 1–2. *pp.* 7–50, 1928.

The author used observations of air and sea temperature, salinity of the water and wind from 46 stations over different parts of the Baltic Sea. Rapid changes of temperature and salinity were found at the surface and below under certain conditions of wind, more especially near the Gulf of Bothnia. With strong northerly winds the surface air and water temperatures fall and the salinity of the surface water increases on the windward side, but the vertical temperature gradient and salinity increase. On the leeward side the salinity in the lower layers increases. It is explained that the surface water is blown before the wind and cooler, more saline water from lower levels rises on the windward side, but the fresher surface layers sink on the leeward side. A similar effect is obtained with

southerly winds, but the changes are less clearly shown. In Danish waters the effect is lost by the outflow of the surface water to the North Sea. The changes occur only when a vertical temperature gradient occurs in the sea and are thus shown best in June and July. Rapid temperature rises in surface water do not occur simultaneously over the Bothnian Sea, but only at scattered stations and less frequently and mostly in shallow water. Changes in salinity do not then occur. R. S. R.

2933. Nocturnal Fluctuations of Atmospheric Azone. D. Chalonge. *Comptes Rendus*, 186. *pp.* 1856–1858, *June* 25, 1928.

Measurements were made from October 1927 to April 1928 of the thickness of the O_3 layer during the day and the following night by photographing the ultra-violet spectrum of the sun or moon in the region 3100–3250 Å., where absorption begins to be appreciable and is not very strong. The results are tabulated to give the thickness of O_3 in units of 0·01 mm. at normal temperature and pressure and the values compared with those at Arosa and Oxford on the same dates. It is concluded that (1) the upper atmosphere never has less O_3 at night than at day, and (2) the nocturnal thickness shows a mean value of 335 on the scale chosen, and no seasonal variation is found during the period tested. R. S. R.

2934. Law of Variation of Atmospheric Density as a Function of Height. R. Esnault-Pelterie. *Comptes Rendus*, 187. *pp.* 55–56, *July* 2, 1928.

The author gives three equations which can be employed for the variation of density with height and which he claims are true to 1 %. One of these requires measurements of p and T only. R. S. R.

2935. Law of the Constitution of the Atmosphere. R. Esnault-Pelterie. *Comptes Rendus*, 187. *pp.* 241–242, *July* 23, 1928.

Values of the temperature gradient at the surface and 10 km. are calculated for different laws of the variation of temperature with height, and one of the form $dT/dZ = -k(h + Z)^{1/3}$ represents the results most satisfactorily. Values are then set out for the ratios of the air densities at 10·5 km. and the surface, for surface temperatures from − 5° to 30° C. The density at 10·5 km. increases almost linearly as T_0 increases, whereas the density at the surface decreases. The author calculates that at 5170 metres the density will be exactly independent of T_0. R. S. R.

2936. Hypothesis that the Highest Atmospheric Layers are Heated by β-Rays. H. Petersen. *Phys. Zeits.* 29. *p.* 492, *July* 15, 1928.

The author replies to objections raised by W. Anderson [see Abstract 1853 (1928)] to the author's explanation of the phenomena and, while admitting the difficulties, he considers this satisfies the aurora observations better than any other. R. S. R.

2937. Petersen's Hypotheses that the Highest Atmospheric Layers are Heated by β-Rays. W. Anderson. *Phys. Zeits.* 29. *pp.* 492–493, *July* 15, 1928.

The author considers Petersen's calculations [see preceding Abstract and 2835 (1927)] are valid only if the β-radiation is not appreciably mixed

with positive atomic ions. If the latter occur a much larger velocity is used for them than any yet found. He inclines to the view expressed by A. Milne that ionised Ca vapour by selective radiation pressure can reach the regions of the earth. The maximum velocity of the Ca is $1{\cdot}6 \times 10^6$ cm./sec. These protuberances reaching the upper atmosphere will not charge it, since positive and negative charges are in equal amount, but may heat it. The positive Ca ions will play the greater part, since their mass and kinetic energy are many thousand times greater than those of the electron. R. S. R.

2938. Fireball Catalogue of von Niessl and Hoffmeister. W. J. Fisher. *Harvard Coll. Obs., Circ. No.* 331. *pp.* 1–8, 1928.

In this catalogue the heliocentric velocities of 611 great meteors are given, computed from the observations, and 79 % are hyperbolic. As this result is surprising, the author has studied the catalogue, and compared with it four other lists of meteors, observed or photographed. It appears that the frequency of these hyperbolic meteors changes with the earth's position in her orbit in the same way as the frequency of all the other meteors; that some of their radiants cluster, both in celestial position and time, about well-known shower-radiants; and that hyperbolic velocities preponderate among a class of meteors in the catalogue which should not show them at all. It is concluded that there is probably a systematic error in the observations, leading to an overestimate of the apparent velocities. M. A. E.

2939. Further Studies in Terrestrial Radiation. G. C. Simpson. *Roy. Meteorolog. Soc., Mem.* 3. *pp.* 1–26, *July*, 1928.

A further contribution in extension of a previous paper [see Abstract 1525 (1928)]. The procedure differs in that in the present treatise each wave-length has been assigned its appropriate absorption with regard to water vapour instead of the former method of assuming that water vapour absorbs like a grey body. Two corrections are therefore necessary from the results of the former paper. These erroneous conclusions were: (1) The outgoing radiation originates in the layers of the atmosphere which have temperatures between 220 Å. and 286 Å. and are therefore within the troposphere; (2) the stratosphere provides an insignificant amount of terrestrial radiation. It is now shown that with clear skies in middle latitudes the radiation is provided by the surface, the atmosphere and the stratosphere as follows: 38 % from the stratosphere alone, 32 % from the surface alone, 30 % from the surface atmosphere and the stratosphere in different proportions. The proportions are slightly different in different latitudes, while with overcast skies the contribution from the ground is replaced by a smaller contribution from the clouds. The new assumption and results show that the stratosphere sends on the average a downward flux of long-wave radiation of more than 43 % of the solar radiation, *i.e.*, more than 0·120 cal./cm./min. The laws governing nocturnal radiation have been indicated and approximate values obtained for the outgoing radiation of the earth and its atmosphere, by using the observed temperatures of the earth's surface and of the stratosphere, together with values for the absorption coefficients for water vapour and carbon dioxide from observed results. Figures were evaluated for the horizontal transfer of heat across circles of latitude essential for the radiative equilibrium of the whole atmosphere. Changes

in solar radiation as regards intensity and the consequences thereof, are discussed, the change in cloud amount being shown to be the chief agency by which radiative equilibrium could be restored. Increase of solar radiation would result in increased cloud and precipitation, whilst decreased solar energy would be followed by decreased cloud and precipitation. The possibility of increased solar activity leading to an " ice age " is dealt with in the discussion. S. G. B.

2940. Lead Isotopes and the Problem of Geological Time. C. S. Piggot. *Washington Acad. Sci., J.* 18. *pp.* 269–273, *May* 19, 1928.

The author enumerates the difficulties existing in determinations of the age of rocks from chemical analyses where the amount of lead present is used and account is taken of the sequence of changes in its derivation from uranium or thorium. The uncertainties regarding the dissociation of the Th series vitiates the calculations of age. In a new method isotopes of lead are identified with the help of the mass spectrograph, and, since the actual weights of U and Pb are known from chemical analysis, a direct comparison of the amounts of uranium and uranium-derived lead can be made. Samples of lead tetramethyl have been tested and lead isotopes separated and identified. It is hoped in this way (1) to determine directly the U : U-Pb ratio for a sample of broggerite and so get a reliable estimate of its age, (2) to determine definitely the Th : Th-Pb relationships, and (3) to throw some light on the other isotopes of lead and their origin. R. S. R.

2941. Earth Tremors due to Tramways. W. Schneider. *Zeits. f. tech. Phys.* 9. 1. *pp.* 11–14, 1928.

Experiments carried out at Potsdam to obtain seismographs of tremors due to wagons travelling on tramways show that the vertical component of the motion is the greater. The period is independent of the speed, type, and load of the wagon. But the amplitude depends on the speed of and the amount of unsprung load on the wagon. At speeds of 30 km. per hour and upward strong vibrations appear even on a smooth track, caused by more or less violent horizontal or vertical swaying of the wagon. W. A. R.

2942. Regional Isostasy. G. R. Putnam. *Nat. Acad. Sci., Proc.* 14. *pp.* 407–418, *May*, 1928.

Isotatic compensation of topography must be to some extent regional. Departure from local compensation must be considered in a complete reduction of gravity observations. A method of regional isostatic reduction applied in the paper to mountainous regions gives closer results to the truth than the Hayford method based on complete local compensation. W. A. R.

2943. Isostasy. G. R. Putnam. *Nat. Acad. Sci., Proc.* 14. *pp.* 418–427, *May*, 1928.

The method previously applied [see preceding Abstract] is a simple gravity reduction based on a calculation of average elevation. The average elevation within 100 miles of the station is obtained from maps, dividing them into suitable strips or zones. The gravity correction is calculated as the algebraic sum of corrections for elevation, the attraction of matter above sea-level, the isostatic compensation, and the topo-

graphic correction. The last is applied only to stations—*e.g.*, mountain summits—where the surface about the station departs considerably from a plain. The compensation is simpler and more accurate than earlier methods. W. A. R.

2944. Isogeothermal Surfaces. C. E. van Orstrand. *Am. J. Sci.* 15. *pp.* 495–519, *June*, 1928.

The nature of isogeothermal surfaces is discussed from a theoretical and hypothetical standpoint. The isogeothermal surface of an ideal globe is an oblate spheroid with the flattening at the poles of the earth. Superposed on the uniform surfaces of equal temperature are the depressions due to ocean floors, lake and sea bottoms, and the various effects produced in the distribution of temperatures at the surface of the earth by currents in the earth's atmosphere. The isotherms diverge beneath mountain peaks and converge beneath valleys. The effects due to the nature and dip of strata are discussed, and curves are computed to show roughly the capacity of different substances (paraffin, water, copper, iron, granite, sandstone and limestone) to transmit heat to the surface of the earth. A table is given of temperature data obtained from wells and mines of exceptional depth distributed throughout the world, and some preliminary generalisations are made relating to the coordination of the data of observation with theory and hypothesis. L. L. B.

2945. Geophysical Prospecting in America. D. C. Barton. *New Zealand Journ. of Sci.* 10. *pp.* 48–52, *May*, 1928. *Reprint from Economic Geology.*

An historical summary is given of the development of four methods: (1) Eötvös gravimetric, (2) seismic or sonic, (3) electrical, and (4) magnetometric. Modern applications of the methods are examined and their possibilities for discovering geological structure, gravity anomalies, mass, and seismic, electrical and magnetic conductivity. R. S. R.

2946. Telluric Currents and Electrical Prospecting. E. G. Leonardon. *Terr. Mag.* 33. *pp.* 91–94, *June*, 1928.

Observations on potentiometer methods of testing telluric currents in the neighbourhood of a fault, with the view of detecting and locating more conductive tracts of rock. A. D.

2947. Experiments in Underthrusting. G. R. MacCarthy. *Am. J. Sci.* 16. *pp.* 51–67, *July*, 1928.

The author describes the results of experiments made to find the conditions under which underthrust faults and underturned folds formed and to study the effects by a plastic supporting layer on the form of the structures developed by compression in the materials above it. Wax models were employed floated on a basal layer of plastic modelling clay mixed with vaseline and with an overload of lead shot. In none of the tests were any criteria discovered by means of which under- and overthrusts might be distinguished by an examination of the structures themselves. It was concluded that underthrusts are favoured by great plasticity of the substratum, upward-moving resistances and unequal distribution of overburden, the latter being especially effective when the greater weight lies upon the side of the compressed zone farthest from the point at which the active pressure is applied. Overthrust structures

are favoured by the contrary of these conditions. With no plastic substratum present the effects of unequally distributed overburden are reversed, underthrusts then being favoured by the greater weight lying near the point where the tangential pressure is applied and overthrusts by this excess weight being on the side of the compressed zone farthest from this point. Further, when these conditions are applied to the Rocky Mountain and Appalachian regions a fairly good case for underthrusting can be made for the former mountains, while for the latter the problem still remains indeterminate. R. S. R.

ASTROPHYSICS.

2948. Solar Chromospheric Images obtained in the Spectroheliograph with the Infra-Red Ionised Calcium Line, λ8542. L. d'Azambuja. *Comptes Rendus*, 187. *pp.* 201–203, *July* 23, 1928.

This infra-red line is the most important of the group containing λ8498 and λ8662; it does not show the double reversal seen strongly in violet lines H and K; on quiet regions of the solar disc it shows a central dark region of about 0·50 Å. width, with wings as in hydrogen; on faculæ a diffuse strengthening not separable into components, and merging into the continuous spectrum; at the limb the line is lance-like and is prolonged feebly in a prominence. With the slit set on its centre, these images are analogous to K_3; the brilliant faculæ and the dark filaments (absorption markings) characteristic of these are clearly shown; the granulation seen in the reversing layer in 1927 has not been observed, probably needing greater light concentration. A. S. D. M.

2949. Stokes' and Poincaré's Theorem. P. Dive. *Comptes Rendus*, 187. *pp.* 104–106, *July* 9, 1928.

Stokes' and Henri Poincaré's theorem is that when the free surface of a planet is orthogonal to the gravitational field the potential of the attraction on an external point depends only on the total mass, the speed of rotation and the free surface. The author has succeeded in completely removing the restriction on this theorem. A. D.

2950. Accuracy and Control of Measurements in the Determination of Longitude. A. Lambert. *Comptes Rendus*, 186. *pp.* 1425–1427, *May* 21, 1928.

The first section of the paper deals with errors proceeding from astronomical observations, following which comes a discussion of errors of radiotelegraphic origin. The conclusion is drawn that differences of longitude adopted for fundamental stations taken two at a time do not contain the above errors exceeding 0·02 and 0·01 sec. respectively.

H. H. Ho.

2951. Variation of the Latitude of the Paris Observatory. (Mrs.) E. Chandon. *Comptes Rendus*, 186. *pp.* 1823–1825, *June* 25, 1928.

From observations made with a prism astrolabe it is shown that the mean error of each latitude obtained lies between ± 0·12″ and ± 0·26″. Comparing the mean latitude determined in 1926 with that obtained in 1917, there is only a difference of ± 0·02″, the observations being made on stars which are mainly different. These results show that a prism

astrolabe can be satisfactorily used for the study of the variation of the latitude, provided that the results of one observer only are compared.

R. C. F.

2952. Use of the Astrolabe for the Study of Latitude Variation. A. Gougenheim. *Comptes Rendus*, 187. *pp.* 281–284, *July* 30, 1928.

At the stations of Algiers, San Diego, Zikawei and Paris, longitude observations by the astrolabe have been published by Ferrié, but evening observations, together with pendulum corrections, give corrections to latitude. Curves for the two observers show, under a slightly different form, the semi-lunar period 14 days noted by Boccardi since 1913, but the amplitude is probably 1″ as compared with Boccardi's value of 0″·3 in 1912 and 0″·2 in 1918, and is ten times the predicted value.

A. S. D. M.

2953. Thermodynamic Equilibrium in the Universe. F. Zwicky. *Nat. Acad. Sci., Proc.* 14. *pp.* 592–597, *July*, 1928.

Makes use of the postulate of a thermodynamic equilibrium in the universe which has to be applied simultaneously to the chain of reactions: Radiation $\rightleftarrows$ protons, electrons $\rightleftarrows$ higher nuclei $\rightleftarrows$ dust particles $\rightleftarrows$ gaseous nebulæ $\rightleftarrows$ stars $\rightleftarrows$ swarms of stars (Galactic systems). The process ν atoms $\rightleftarrows$ one star is specially considered, using the data known for the sun, and supposing initially all stars to be of the same size. Makes an estimate of the average potential energy of one atom in the star, and shows that the average kinetic energy is small as compared with this. It becomes possible to use the statistical treatment of a chemical reaction in the form given by Ehrenfest and Trkal, and to obtain an expression for the equilibrium constant in terms of the total numbers of free atoms and of stars, and the volume of the universe. It appears that the vapour pressure in the interstellar space will, according to the theory, be extremely small, and that practically only stars of nearly one size will be formed. Points out the difference between the "gas" made up by the stars and a "van der Waals gas"; the star gas may be compared with a space charge made up of ions of one sign only, and correct results can only be obtained by considering the system as a whole. Shows that it is impossible for dust to be distributed throughout interstellar space, though clouds of dust may exist in the vicinity of stars. The postulate of thermodynamic equilibrium in the universe is not justified by the facts as far as the distribution of radiation and the equilibrium between matter and radiation are concerned; the problem, however, requires reconsideration on a broader basis.

H. N. A.

2954. Cause of the Ellipsoidal Distribution of Stellar Velocities. B. Lindblad. *Arkiv f. Mat. Astron. och Fysik, Stockholm*, 20. *No.* 17. *pp.* 1–7, 1927.

A theory of stellar motions has been developed in previous papers, and it has been found that the galaxy has a general motion of rotation round a distant centre situated in the direction of galactic longitude about 330°. This view has recently received very strong support in the results of Oort, who finds that our place in the stellar system has a distance of 5000 parsecs from the centre, and a rotation of 300 km./sec. round it. It is, however, probable that every part of the galactic stratum is traversed by many streamings in all directions, and it is shown here that these streamings,

under a force of the kind found by Oort, will show an *apparent preference* for the direction towards and away from the centre of the system: this explains quantitatively the phenomenon of ellipsoidal star-streaming. The vertex line for the A-type stars in our neighbourhood is, however, somewhat deflected by the special Ursa Major stream. Recent investigations of distant stars in the Greenwich zone have further shown that the phenomenon seems to be constant within wide limits of space, which speaks strongly in favour of the present theory. M. A. E.

2955. Relation between Mass and Absolute Magnitude. K. Lundmark and W. J. Luyten. *Arkiv f. Mat. Astron. och Fysik, Stockholm*, 20. *No.* 18. *pp.* 1–13, 1927.

This problem was studied in 1910 by Schlesinger and Baker, who used data derived from spectroscopic binaries; and in 1913 Hertzsprung deduced a linear relation between the logarithm of the mass and the logarithm of the luminosity from a few stars in the neighbourhood of the sun. In 1923 Adams and Joy derived a formula from a large number of spectroscopic and dynamical parallaxes, and Eddington attacked the problem from the theory of radiation within a star. Valuable fresh material has now been used by the authors of this paper, taking their data from spectroscopic binaries whose separate spectra have been seen and compared, and from 18 visual binaries. In spite of some difficulties, it is shown by a diagram that good agreement exists between their results and those of Eddington. Eddington's curve represents bolometric, and not visual magnitudes, but a rough calculation shows that only small corrections will be necessary to make the results strictly comparable. M. A. E.

2956. Form of Absorption Line in Rotating or Expanding Star Spectrum. J. A. Carroll. *Roy. Astron. Soc., M.N.* 88. *pp.* 548–555, *May*, 1928. *Observatory*, 51. *pp.* 181–183, *June*, 1928.

An investigation of the two cases of stellar (*a*) expansion and (*b*) rotation, for (1) relative Doppler displacement through reduction of central spectral intensity, and (2) through reduction of the integrated spectrum near the limb by darkening. In (1) the effect is of displacement without change of form; in (2) the centre of a symmetrical line is broadened and filled in by an amount depending on the line width and the line of sight equatorial velocity, but is undisplaced. A formula relates the observed width with its true intensity, the rotational velocity and the second differential coefficient of the absorption curve at the line's centre; as the rotating speed is the same for all lines, and the darkening factors (for a close multiplet) nearly the same, the relative intensities need only be known of two lines to deduce the rotational speed. The author gives a figure of the form of an absorption line of half width 0·5 Å.U. at $\lambda 5000$ for various equatorial velocities of V and as lines of this half-width are common in stellar spectra, but (probably) have a central intensity in general greater than half the continuous background, he concludes (knowing of no spectrum in which every line is weaker than this) that no stars yet found have an equatorial rotation velocity much greater than 50 km./sec., the usual velocity being probably of the order of 10 km./sec. A. S. D. M.

2957. Absolute Magnitudes of Class M Stars. W. J. Luyten. *Nat. Acad. Sci., Proc.* 14. *pp.* 488–491, *June*, 1928.

An investigation of the discrepancies between the work of van Rhijn

with Adams and Strömberg. Of the catalogue of 410 M giants and dwarfs by Adams, Joy and Humason [see Abstract 601 (1927)], the author considers the 271 stars included in Boss's Catalogue and 34 fainter stars in selected areas; these forming a homogeneous group representative of M giants in space. Van Rhijn's material is not homogeneous, and a figure shows the discrepancy between the two. He divides the 271 Boss stars into four groups according to their galactic latitude and determines the mean absolute magnitude and dispersion for each group. For M stars, he concludes that it is sufficient to know that it has a galactic latitude $>20°$ to predict its absolute magnitude with a mean error of only 0·34. If its galactic latitude $<20°$, an assumption that the absolute magnitude of an M star is constant and $= -0·6$, gives as good a parallax as a single spectroscopic determination [see also Abstract 2248 (1927)]. The Mt. Wilson line-intensity criteria may be used to distinguish between giants and supergiants, but cannot be correlated with the small differences in absolute magnitude between ordinary giants. A. S. D. M.

2958. Advance of Periastron in Eclipsing Binaries. H. N. Russell. *Roy. Astron. Soc., M.N.* 88. *pp.* 641–643, *June*, 1928.

The author considers the motion of periastron, P′, of a small satellite about an oblate planet in an orbit of small eccentricity with period, P, such that $P/p' = r^2(e - \frac{1}{2}\phi)a^{-2}$, where e is the superficial ellipticity of the planet and ϕ the ratio of centrifugal force to gravity at its equator, and $k = e - \frac{1}{2}\phi$, which depends on the planet's internal constitution and ranges from $\frac{3}{4}\phi$ for a homogeneous body to zero for one with the whole mass at the centre. He obtains equations for the motion of periastron of two oblate spheroids about each other, and for eclipsing binaries (whose periods of revolution and rotation at their surfaces are the same) where there is ellipticity due to tidal distortion as well as rotation, and he finds the perturbative force; applying it to the case of Y Cygni for which P′ = 5400 P. Here under certain assumptions he finds $k = 0·076$, so that Y Cygni is more condensed at its centre than Saturn ($k = 0·12$). Applying this to stars of different constitutions he finds that for those built on Eddington's model, P′ is only one-fifth of its observed value, and explains this by Jeans' "radiative viscosity" [see Abstract 2304 (1926)] which shows that the inner portion of a star should rotate more rapidly than the outer layers. The angular velocity in the central part may be 10 times that at the surface and the rotational velocity 10 or 50 times that calculated for Y Cygni, and the central density 25 to 120 times its mean density ($0·17\odot$), but the motion of periastron might be slow.

A. S. D. M.

2959. Period of the Spectroscopic Binary 36 τ^9 Eridani. C. Hujer. *Astrophys. J.* 67. *pp.* 399–404, *June*, 1928.

The period of 36 τ^9 Eridani was re-examined on the basis of observations recently published by the Lick Observatory and new plates lately secured at Yerkes Observatory. The mean period $0^d·85441$ previously found was adjusted to $0^d·85423$ to include the recent observations. As the previous results [see Abstract 3072 (1927)] suggested that the period might be variable, the recent observations were compared with the earlier ones. The distribution of residuals indicated no secondary period. Observations, being possible only near the meridian on account of the star's southern declination, made this case suitable for the use of the

formula for the alternative periods $p_1 = p_3/(1 - p_3)$, $p_2 = p_3/(2p_3 - 1)$, $p_3 = 0^d{\cdot}85423$. In view of a large scattering p_2 was discarded; p_1, as well as p_3, gives a satisfactory velocity curve, and either one can be used for determining the elements of the orbit. There is at present no way of deciding which is correct until a few spectrograms can be obtained at a longitude widely differing from that of the Yerkes Observatory. The elements were determined by Laves' hodographic method as modified by Pogo. AUTHOR.

2960. Four Long-Period Spectroscopic Binaries. H. S. Jones. *Roy. Astron. Soc., M.N.* 88. *pp.* 644–659, *June*, 1928.

A combination of the Lick and Cape observations to deduce the orbital elements of β Reticuli, τ Puppis, λ Hydræ and α Tucanæ. The last is the spectroscopic binary of longest period known. The principal elements are as under:—

	β Reticuli.	τ Puppis.	λ Hydræ.	α Tucanæ.
Type.....	K0	K0	K0	K2
P (days)	1911·5	1066·0	1585·8	4197·7
V_0 (km./sec.)	+ 51·11	+ 36·36	+ 19·39	+ 42·24
K (km./sec.)	5·19	4·14	3·74	7·23
e	0·210	0·088	0·138	0·385
ω	13°·8	64°·0	238°·9	48°·5
$a \sin i$ (10^6 km.)	133·4	60·5	80·8	385·1
$f \odot$	0·0260	0·0078	0·0084	0·1295

The author urges the importance for statistical purposes of orbits of many long-period binaries. There are probably many of G, K, or M type whose velocities are regarded as constant, but they are really spectroscopic binaries of long period and small velocity range. A. S. D. M.

2961. Bright Iron Lines in the Spectrum of H.D. 45677. P. W. Merrill. *Mt. Wilson Observat., Contrib. No.* 355. *Astrophys. J.* 67. *pp.* 405–408, *June*, 1928.

The spectrum of H.D. 45677 is B2 with numerous superposed bright lines due chiefly to hydrogen and ionised iron (FeII). The bright hydrogen lines are double, with the component of longer wave-length the more intense. About half of the bright iron lines are forbidden lines recently recognised in the spectrum of η Carinæ. The apparent radial velocity derived from the bright lines is + 19 km./sec.; from the absorption lines + 25 km./sec. AUTHOR.

2962. Nova Pictoris. J. Jackson, P. J. Melotte and W. H. Steavenson. *Observatory*, 51. *pp.* 183–185, *June*, 1928.

The large Johannesburg refractor show a nebulous image of the star with four rings of radius about 98″, 64″, 42″ and 19″; with increasing exposures the star disc grows to envelop the inner rings. Paraskévopoulos, of the Harvard station at Bloemfontein, has obtained objective prism spectra which show rings (radius 84″) like those of the Lyra ring nebula. The refractor rings are probably optical, and due to the colour correction of the Franklin-Adams lens whose spherical correction becomes pro-

gressively worse with greater deviation from the wave-lengths for which it is corrected. [See also Abstracts 2308 and 2799 (1926).] A. S. D. M.

2963. Photometric Study of Algol. A. Danjon. *Comptes Rendus*, 186. *pp.* 1825–1827, *June* 25, 1928.

Discusses the results of observations made with the cat's-eye photometer [see Abstract 2694 (1928)] on the star Algol. The mean dispersion of the observations is 0·006 m., and from the given light curve Stebbins' discoveries are easily seen. The type of the curve for the secondary minimum is definitely obtained and is more rounded than that for the principal minimum. The magnitude of the principal minimum is variable with a period of four months, and is due to the rotation of the line connecting the orbital nodes. Russell's and Eddington's theories regarding the part of the curve connecting these two minima are not supported. It is not represented by the sum of the terms containing $\cos\theta$ and $\cos^2\theta$, but by a term in $\cos^2\theta$, together with one representing the phase effect. Thus, the light curve is best represented by a solution D, the disc of the star being completely darkened at the edge. The principal minimum is an annular eclipse, the secondary minimum thus being a total eclipse.

R. C. F.

2964. Harvard Catalogue of Long Period Variable Stars. S. D. Townley, Annie J. Cannon and L. Campbell. *Harvard Coll. Astron. Obs., Ann.* 79. 3. *pp.* 161–205, 1928.

A list of 1760 stars compiled from material, both published and unpublished, which was available up to January 1, 1928. The principal characteristics adopted as criteria in assigning stars to the class of long period variables are: (1) A variation in a period of fifty days or more, provided the star had not been assigned definitely to another class of variables; (2) a range of variation of at least two and a half magnitudes, except where published observations prevent the inclusion of the star among the long period variables; (3) a variation of fairly large range, for which observers have stated that the period is probably long; (4) a spectrum of Class Me or Se, generally indicative of long period variation; (5) a light curve of the R Coronæ Borealis, U Geminorum, or R.V. Tauri type, especially if the variation exceeds one magnitude. AUTHORS.

2965. Observed Maxima and Minima of Variable Stars for 1927. L. Campbell. *Harvard Coll. Obs., Circ. No.* 329. *pp.* 1–8, 1928.

2966. Constancy of Light of Red Stars with Forty New Variables of this Class. J. Stebbins and C. M. Huffer. *Nat. Acad. Sci., Proc.* 14. *pp.* 491–496, *June* 15, 1928.

Observations with the photoelectric photometer attached to the 15-in. refractor of the Washburn Observatory were made of all stars of spectrum M in the Harvard classification, north of − 10° Dec. and brighter than 6·0 visual magnitude (corresponding to 7″ photoelectric magnitude). The red (or M) stars were observed in groups of three or four together with one or more yellow K stars for comparison. In all 164 M stars have been tested, using 165 K stars as standards. The classification [see Abstract 601 (1927)] is M0, M1, . . . M6, which is also in the order of increasing redness. Beyond M6 are the long-period variables. The method of observing is described and a range of 0·100 magnitude is taken as the minimum for variability. A table of 24 stars

is given where there is greater variation than 0·20 magnitudes, and shows the tendency to variability with increasing redness—any distinctly red star (*i.e.*, of classes M4 to M6) is almost certainly variable to the extent of 10 % or more; there is also a tendency to greater variability with brighter absolute magnitude; extreme luminosity or extreme redness go with variability. The very red stars are very young, with irregular output of radiation, but with age the variations keep within limits; no star drops out of sight and no newcomer reaches Betelgeuse. The red stars contract, grow hotter, and become yellow K stars in cosmic time.

A. S. D. M.

2967. Variable Star X Sagittarii. G. Tiercy. *Arch. des Sciences*, 10. *pp.* 159–190, *May–June*, 1928.

Photographs were taken at Arcetri Observatory (Florence) between June 9 and August 22, 1927. The general methods of measuring and computing were similar to those employed for T Vulpeculæ [see Abstract 2647 (1928)]. Simplified formulæ are given for computing the widths of lines and the lengths of spectrum. The author compares his light curve with those of Pickering, Moore and Voûte, differing from the first two and agreeing with the last. Maximum light corresponds to photographic magnitude $4^{m}\cdot96$ and phase $5^{d}\cdot595$; mass = 8.5; radius of star varies from 17,457,964 to 14,957,484 km.; temperature from 7285° to 5772°; pressure from 0·002535 to 0·001929 atm.; $I_{max.}$ corresponds to G5 and $I_{min.}$ to F_1; minimum and maximum radial velocities follow maximum and minimum light by 0·30 and 0·63 days respectively. He compares the behaviour of the star with T Vulpeculæ, and suggests that some of the differences are due to greater atmospheric (terrestrial) absorption in the southern star X Sagittarii, which should be studied from a station in the southern hemisphere.

A. S. D. M.

2968. Variations of α Orionis and α Scorpii. H. S. Jones. *Roy. Astron. Soc., M.N.* 88. *pp.* 660–679, *June*, 1928.

A combination of Lick and Cape observations of the radial velocities of Betelgeuse and Antares, so as to find the best " orbital elements " as though they were spectroscopic binaries. The total range of variation is in each case of the order of 4 km./sec. Betelgeuse is known to be an irregular variable star [see Abstract 2966 (1928)] and observations with a selenium photometer definitely show short period variations of estimated period of 250 days superimposed on one of about six years. The author correlates its radial velocity and its brightness and finds it similar to many Cepheid variables for which the maximum light usually occurs slightly before the maximum velocity of approach. Probably the mean radial velocity variation has a variable period and amplitude. For Antares also there is both a short-period and a long-period (about seven years) oscillation in velocity, but it has no variation in light. Taken as pulsating stars, both Betelgeuse and Antares have larger pulses than any other known stars; their pulses exceed the theoretical amplitude found by Eddington. For normal Cepheids, $\Pi\sqrt{\rho_c}$ averages 0·8 with an extreme value of 1·4 (Π is the period of variation and ρ_c the central density), but for these two red stars the values are 12·1 and 10·8. This implies that the ratio of the specific heats of their constituent matter approaches more nearly to the value 4/3 than in the case of a Cepheid.

A. S. D. M.

2969. Presence of Aluminium Radiation Bands in Spectrum of Mira Ceti at Maximum of February 1924. F. E. Baxandall. *Roy. Astron. Soc., M.N.* 88. *pp.* 679–683, *June,* 1928.

The author made enlarged copies of Joy's *o* Ceti spectra [see Abstract 2801 (1926)] and several laboratory spectra of aluminium oxide of varying dispersions were enlarged to the same scale. He gives a table of recorded absorption bands in Mira which have hitherto been unidentified, and concludes that absorption bands of aluminium oxide exist in the normal spectrum of the star, and all the recorded bands other than those of TiO_2 may be ascribed to aluminium. A. S. D. M.

2970. Further Observations of Some Bright Hydrogen-Line Stars, 1924-1927. W. J. S. Lockyer. *Roy. Astron. Soc., M.N.* 88. *pp.* 683–695, *June,* 1928.

A continuation of previous observations [see Abstract 2225 (1924)] and embracing the period 1924 March to 1928 April. The total number of photographs obtained in this new survey is 546, and they are taken with the 9-in. prismatic camera having a 45° angle prism and a dispersion of 46·0 mm. between H_β and H_δ. The stars are mostly of type B_3 and are marked by broad absorption bands of hydrogen on which are generally seen double bright sharp components symmetrically placed on them; these may or may not vary their relative intensities. Variations have been seen in the appearance of H_β in H.D.C. 20336 [see Abstract 2792 (1926)]; ϕ Persei [see Abstracts 2047 (1925) and 2307 (1926)]; ζ Tauri; Merope and β Canis Minoris. Most of the other stars examined do not seem to have varied their spectra. A plate is given of the comparison of spectra of ζ Tauri, κ Draconis, β Piscium and 23 Tauri, with the helium star γ Orionis. The plate also shows that the region between the ionised double lines at $\lambda\lambda 4173{\cdot}5$ and $4178{\cdot}9$ and the ionised line at $\lambda 4238{\cdot}8$ has almost continuous homogeneous absorption, and this is common to most bright-line hydrogen stars and is also seen in γ Orionis, which is a pure absorption spectrum only. The cause is unknown. A. S. D. M.

2971. Gravitational Parallaxes. K. Lundmark. *Arkiv f. Mat. Astron. Och Fysik, Stockholm,* 20. *No.* 20, *pp.* 1–15, 1927.

For parallaxes from the dimensions of binary star orbits, the author uses the formula—

$$1/\pi = \Delta = 0{\cdot}033598(1-e)^{\frac{1}{2}} \times \left[V_1 - V_2 - 0{\cdot}621\{\mu_A/R_A - \mu_B/R_B\}P[a \sin i(e\cos\omega + \cos(v+\omega))]^{-1}\right],$$

correcting where possible for the Einstein shift. A summary is given of the results for all (12) the gravitational parallaxes determined, with special notes on Σ 3062, η Cassiopeiæ, Σ 1785, α Centauri, and 61 Cygni. For parallaxes from the relative motion of double stars (dynamical parallaxes), he derives the formula:—

$$\pi = \rho[(\mu_1 + \mu_2)^{\frac{1}{2}} \sin i]^{-1}[(d\theta/dt)^2 - (d^2\rho/dt^2)(4\pi_c\rho)^{-1}]^{\frac{1}{2}},$$

where ρ and θ are distances and position angles, $\pi_c = 3{\cdot}1415$ and $\mu_1 + \mu_2$ are the sum of the masses in terms of the sun. Notes are given on A 1585, X Ophiuchi (a long period variable being one of the components of a visual double), Mizar (observations on four successive nights with the interferometer give its right order of parallax), θ Eridani, and the dynamical parallaxes of five other doubles. A. S. D. M.

2972. Correction to Spectroscopic Parallaxes. D. L. Edwards. *Roy. Astron. Soc., M.N.* 88. *pp.* 695–700, *June*, 1928.

In the spectroscopic determination of parallaxes, spectroscopic binaries are either ignored on the assumption that the secondary emits a negligible fraction of the combined light, or a haphazard correction is applied. The author suggests the assumption that the difference in magnitude between the components, instead of being large, is equal to some suitably chosen constant value such as the average value of this difference in visual binaries. He takes from Aitken's *The Binary Stars* the value $\Delta m = 0 \cdot 9$, and in the application to spectroscopic binaries he suggests for the reduction of the total magnitude to that of the primary (m_1): $m_1 = m + 0 \cdot 4$. The effect of ignoring the correction is twofold: in the formation of the standard reduction curves or tables connecting spectroscopic criteria with absolute magnitude, and in the deduction of parallaxes from the absolute magnitudes. He tests his assumption by a comparison of published spectroscopic parallaxes with standard trigonometric and group parallaxes and deduces a series of corrections to existing spectroscopic parallaxes. A. S. D. M.

2973. Remainder Formula and its Use in the Development of the Disturbing Function by Harmonic Analysis. E. W. Brown. *Roy. Astron. Soc., M.N.* 88. *pp.* 624–634, *June*, 1928.

The author urges that double harmonic analysis, in which the angles are of the form $i\theta \pm i\theta'$ (i, i' integers), can be reduced to a number of single analyses and the work carried out in parallel columns with reduction of work. He finds a formula for the remainder after i terms of the function $(1 - 2\alpha \cos \psi + \alpha^2)^{-s}$ expanded in a cosine Fourier series with argument ψ. In practice the values are found as $i = 9$ and $s = \frac{1}{2}$ or $\frac{3}{2}$. He shows how the disturbing forces are obtained and outlines the method of performing the double harmonic analysis. He considers the errors of the coefficients when 16 special values are used, and gives the caution that before changes in the plans outlined or the numbers recommended are made, a careful examination should be undertaken of the effect of such change on each part of the work. He indicates eight defects or advantages of double harmonic analysis. A. S. D. M.

2974. Light-Curve and Elements of Photometric Double-Star, β Lyræ. A. Danjon. *Comptes Rendus*, 187. *pp.* 279–281, *July* 30, 1928.

In 1923–24, 200 observations were made at Strasbourg, the visual companion serving as a comparison star. The author finds that Hellerich's Ephemerides have phases too short by 0·11 day; the mean light is symmetrical except near the principal minimum phase ($\pm 0 \cdot 5$ day), the spectrum of the component B_{3e} being equally dissymmetrical; the light curve has deformations whose maxima have a period of 156 days; Miss Blagg's secondary period of 6·57 days is not confirmed; the component B_{3e} is abnormal, its effective temperature being below those of its sub-class, and it is redder than the component ${}_cB_9$. If it were normal and its absolute magnitude $= -2 \cdot 8$ m. the parallax of β Lyræ would be 0·003. The elements of the binary are given. A. S. D. M.

LIGHT.

2975. Composition of Colours. G. Giorgi and Maria Rosati. *N. Cimento*, 5. *pp.* 167–180, *May*, 1928.

Comparison of the various theories propounded from the time of Newton to represent the composition of colours. These are all in disaccord with experimental observation, and in particular Helmholtz's laws must be given up. A. D.

2976. Penetration of Ultra-Violet Light into Pure Water and Sea-Water. E. O. Hulburt. *J.O.S.A. and R.S.I.* 17. *pp.* 15–22, *July*, 1928.

With a quartz spectrograph, sodium hydride quartz photoelectric cell and quadrant electrometer, measurements were made in the ultra-violet spectrum region λ4000 to 2500 Å. of the light absorption coefficients of pure water and sea-water and of the molecular absorption coefficients of aqueous solutions of the principal salts in the sea, namely, NaCl, KCl, $MgCl_2$, $MgSO_4$ and $CaSO_4$. The transparency of the sea-water declines rapidly with decreasing wave-length in the ultra-violet, becoming quite small below λ3000 Å. From λ3400 to 3000 Å., $CaSO_4$ contributes about half to the absorption of sea-water, H_2O about a fourth and the other salts the rest; from λ3000 to 2500 Å., $MgCl_2$, $CaSO_4$ and H_2O each contribute roughly a third, the other salts giving relatively little absorption. There is a close correspondence between the falling off in the transparency of the sea with decreasing wave-length in the ultra-violet and the spectral energy curve of sunlight. This, together with the very similar correspondence in the case of the transparency of the atmosphere permits the suggestion that the actinic effects of sunlight may have played a part, perhaps more important than has been heretofore recognised, in the constitution of the sea and the air. AUTHOR.

2977. Ultra-Violet, Visible and Infra-Red Reflectivitiesof Snow, Sand and Other Substances. E. O. Hulburt. *J.O.S.A. and R.S.I.* 17. *pp.* 23–25, *July*, 1928.

By means of a quartz mercury lamp, a thermocouple and absorbing screens, the diffuse reflectivities in the region $\lambda 0{\cdot}3$ to 7μ were measured for snow, sand, crushed quartz, plaster of Paris, white paper, white cotton cloth, sodium carbonate and sodium chloride. The ultra-violet reflectivity of snow was relatively high, being two to four times that of sand. This gives a physical basis for the current idea that ultra-violet glare may be an important factor in snow blindness. AUTHOR.

2978. Variation of Refractive Index with Temperature and Density. G. Peters. *Ann. d. Physik*, 86. 4. *pp.* 494–510, *July* 10, 1928.

The author discusses the theoretical considerations in some detail, dealing not only with the formulæ deduced by Newton, Dale and Gladstone, and Lorentz and Lorenz, but also with those obtained from thermodynamic considerations. A practical method is described, using interferometer measurements on liquids, by means of which it is possible to

obtain values of the refractive indices at various temperatures. Results are given for prussic acid, the densities being measured by means of a pyknometer. Refinement of this apparatus should lead to results being obtained which will allow of comparison of the measured and calculated values. This comparison will give a true idea of the respective values of the three formulæ connecting density and refractive index. R. C. F.

2979. Theory of Forced Double Refraction (Photoelasticity). K. F. Herzfeld. *J.O.S.A. and R.S.I.* 17. *pp.* 26–36, *July*, 1928.

The double refraction of crystals may be due (1) to anisotropy of the ions taken separately; (2) to the anisotropic arrangement of the ions in the lattice, which results in an anisotropic force even if the ions are undisturbed; (3) to an anisotropic Lorentz-Lorenz force due to the anisotropic arrangement of the ions. Ewald and Bragg have assumed (3) alone to be present. Here calculations are made for effect (3) in cubic crystals under stress (forced double refraction, photoelasticity). The effect seems not to be explained entirely by (3). Incidentally it is shown how the Lorentz-Lorenz force is built up in the unstrained crystal. It turns out that the force $4\pi P + 4\pi/3P$ is almost entirely due to the plane passing through the considered ion. AUTHOR.

2980. Magnetic Double Refraction of Mixtures of Liquids. G. Szivessy and M. Richartz. *Ann. d. Physik*, 86. 3. *pp.* 393–421, *June* 30, 1928.

Previous tests of optical and magnetic anisotropy of liquids did not satisfy Langevin's theory for the dependence of the results on temperature. The authors describe further tests by measurement of the magnetic double refraction of liquid mixtures. In the binary mixtures one component has a large and the other a small, but easily measurable Cotton-Mouton constant. The refractive indices were determined for thirteen different binary mixtures by means of a Pulfrich refractometer and the results are expressed in tables and graphically as a function of the volume concentration of the components. With a few exceptions it was found that the observed values of the magnetic double refraction were smaller than the calculated values and in some cases considerably smaller. R. S. R.

2981. Conjugate Surfaces of a Spherical Refracting Surface. J. P. C. Southall. *J.O.S.A. and R.S.I.* 16. *pp.* 380–397, *June*, 1928.

Refers to a paper by T. Smith, "Some Uncultivated Optical Fields" [see Abstract 1541 (1928)]. In a certain sense the present paper may be considered as a commentary on a position of that of Smith, containing some new points of view with regard to geometrical optical problems. Deals geometrically with the two kinds of imagery due to refraction at a spherical surface, the primary image, due to the meridian rays, and the secondary image, due to the sagittal rays; the magnification ratio; imagery in the sagittal section; conjugate spheres; the influence of the stop. The paper is illustrated by a number of diagrams. H. N. A.

2982. Primordial Coefficients of Asymmetrical Lenses. T. Smith. *Optical Soc., Trans.* 29. 4. *pp.* 167–178, 1927–1928.

An easily calculable system of sixteen magnitudes is constructed for the representation of the properties of asymmetrical lenses by the addition of four lengths to the magnitudes previously used. The equations con-

necting this system and the coefficients of the eikonal and of the characteristic function, the equations for combining systems or moving their reference points, and the identities between the coefficients are expressed in matrix form. It is shown that the eleven variables present in a system of three separated astigmatic lenses only yield nine degrees of freedom, and such a system cannot, if the reference points are placed where the outer lenses meet the axis, represent the general system, which has ten degrees of freedom. [See also Abstracts 1543 and 1544 (1928).] AUTHOR.

2983. Theory of Aplanatic Surfaces. T. Smith. *Optical Soc., Trans.* 29. 4. *pp.* 179–186, 1927–1928.

The necessary and sufficient condition that an optical system should have a pair of aplanatic surfaces is that the eikonal of the system can be expressed as a homogeneous function of the first order of three variables, each of which is a linear function of the direction cosines of the ray in the object and image spaces. Methods are given for finding the equations of these surfaces when the eikonal is given, and for finding the eikonal when the surfaces are given. Conjugate aplanatic surfaces are similar apart from arbitrary uniform unidirectional extensions or compressions. In general only one pair of aplanatic surfaces is possible, but in spherically symmetrical systems two pairs are found. In addition there may be aplanatic imagery at isolated points. AUTHOR.

2984. Contouring Smooth Surfaces. J. P. Andrews. *Journ. Sci. Instruments*, 5. *pp.* 209–213, *July*, 1928.

By the employment of a very narrow intense beam of light, the shapes of smooth surfaces may be investigated. The paper describes appropriate experiments, and gives the necessary calculations for regular spherical and cylindrical lens-surfaces; a complete, nearly circular, cylinder; and a metal surface of no prescribed figure. The application to glazed porcelain surfaces is alluded to, and it is shown that an accuracy comparable with that of an interference method is attainable by this method. AUTHOR.

2985. Investigation of a Lens by Graphical Methods. J. P. C. Southall. *J.O.S.A. and R.S.I.* 17. *pp.* 1–14, *July*, 1928.

The author provides two alternative methods of constructing the so-called conjugate secondary surfaces of a lens. The graphical methods are explained in considerable detail and they can be extended to the general case of an optical system composed of a centred system of more than two spherical refracting surfaces. R. S. R.

2986. Lens Calculations and the Eikonal. H. E. v. Gronow. *Zeits. f. Instrumentenk.* 48. *pp.* 345–348, *July*, 1928.

Gives examples to show in what manner lens calculations are simplified by the use of the eikonal. A. D.

2987. Errors of a Reflecting Prism. T. Y. Baker. *Optical Soc., Trans.* 29. 4. *pp.* 187–193, 1927–1928.

A prism with two reflecting faces designed to fulfil a particular purpose in an optical instrument gives rise to errors due to (*a*) inaccuracy of manufacture and (*b*) inaccuracy in mounting the prism in the instrument. The effects of these errors are investigated. The special case of the constant deviation prism, in which the three parts of the ray inside the prism

nominally lie in a plane, gives rise to an error of the second order, the value of which is obtained. [See also Abstract 1542 (1928).] AUTHOR.

2988. Interferential Collimator and Prisms. H. Nagaoka and T. Mishima. *Inst. Phys. and Chem. Research, Toyko, Sci. Papers*, 8. *pp.* 215–223, *June* 19, 1928.

Details are given of an interferential collimator, by the use of which the defects due to the loss of light by reflection from the front plate of the interferometer and the centring of circular fringes are eliminated. The device consists of a plano-convex lens with the plane face silvered, opposite and parallel to a plane half-silvered plate. By interposing a fixed etalon between the silvered faces and encasing them so that the system can be screwed to the end of a collimator tube, of which the length is equal to the focal distance of the plano-convex lens, interference rings can be observed with monochromatic light without any further attachment. Any spectroscope to be used with prisms or plane gratings can be transformed into one showing fine structure by replacing the collimator lens by the above system, and the arrangement has the advantage that large portions of the spectrum may be photographed with a single exposure. To eliminate loss of light whilst using an interferometer a device is proposed consisting of two prisms, with etalons of equal length between the half-silvered side faces. By dividing a constant deviation prism into two such prisms, it can be converted into a convenient interferometer, serving at the same time as an analyser of spectra without much loss of light.

L. L. B.

2989. Féry Prisms. A. Biot. *Ann. Soc. Sci. de Bruxelles*, 48. *pp.* 41–48, *June* 21, 1928.

The author develops a formula for the most general combinations of lenses and mirrors, whereby it is possible to calculate the radius of curvature of the caustic from a point source of light at any point in its path through the combination. This formula can also be used for any point of the caustic. Applying this formula to the Féry prism it is found that the radius of curvature of the caustic at the point utilised by the prism is zero, accounting for the remarkable definition obtained from such a prism. A new autocollimating prism which has a large relative aperture is described, whilst possible uses of the formula established are briefly detailed.

R. C. F.

2990. Removal of the Discontinuity in the Resolving Power of the Dark-Ground Microscope. J. Groeneveld. *Zeits. f. Instrumentenk.* 48. *pp.* 349–352, *July*, 1928.

The paper is a mathematical discussion of the resolving power of the dark-ground microscope. The discontinuity of the resolving power is considered from the standpoint of the numerical apertures of the various components of the optical system, and the removal of all discontinuity in resolving power is shown to be a question of suitable numerical apertures.

F. J. B.

2991. The Stereoscope. R. S. Clay. *Optical Soc., Trans.* 29. 4. *pp.* 149–166, 1927–1928.

Historical Summary; Wheatstone's invention; various forms devised by Wheatstone; Brewster's lenticular stereoscope; later forms of stereo-

scope; the pseudoscope; other stereoscopic apparatus in the Wheatstone collection at King's College, London; stereoscopic slides; stereoscopic projection. A. D.

2992. Apparatus for Measuring Spectrum Photographs. R. Frisch. *Zeits. f. Phys.* 49. 7–8. *p.* 608, 1928.

The apparatus consists of a glass scale divided in mm. which can be moved about 1 mm. by means of a micrometer screw with a divided drum. Settings are made on exact divisions of the scale correct to one-hundredth of a mm. F. S.

2993. Ultra-Microscopic Illumination of the Bubble of a Spirit-Level. A. de Gramont and G. Mabboux. *Comptes Rendus,* 187. *pp.* 217–219, *July* 23, 1928.

The projection on the ground of the bubble of a spherical spirit-level is used in certain telescopes for determining the elevation of an aeroplane. A method of lateral illumination of the bubble is now described which makes the method suitable for astronomical observations. T. M. L.

2994. Theoretical Calculation of the Diffusion of Light in a Fluid. J. Cabannes. *Comptes Rendus,* 186. *pp.* 1114–1116, *April* 23, 1928.

2995. Secondary Radiations in the Molecular Diffusion of Light by Liquids. P. Daure. *Comptes Rendus,* 186. *pp.* 1833–1835, *June* 25, 1928.

Confirms previous results [see Abstract 2676 (1928)]. The frequencies of the secondary radiations are given by the formula $N-n_p$, where N is the frequency of the exciting radiation and n_p a characteristic constant for each liquid; probably the frequencies of vibration proper to the molecule are related to the infra-red absorption spectrum. A. D

2996. Diffusion of Light in Crystals. G. Landsberg and L. Mandelstam. *Comptes Rendus,* 187. *pp.* 109–111, *July* 9, 1928.

The authors have succeeded in finding in the diffused light of the principal rays of mercury not only satellites of greater wave-length (Raman and Krishnan, Cabannes and Daure) but also satellites of shorter wave-length, much feebler than the former. A. D.

2997. "Axiality" of Light Emission. R. v. Hirsch and R. Döpel. *Phys. Zeits.* 29. *pp.* 394–398, *June* 15, 1928.

Polemical. A brochure has appeared under the name of J. Stark, in which the theory of the "axiality" of light emission appears, and is partly founded on work done by Stark together with the two authors. According to the authors, some of the experiments were insufficiently exact for drawing the conclusions which Stark has done. They refer to previous work of their own [see Abstract 1333 (1927)] and give some results from their present work, which is not yet finished. They conclude that the "axiality" effect may be real, but that the experiments so far have only been sufficiently accurate to give qualitative information. A. C. M.

2998. Polarisation of Infra-Red Radiation by Calcite. A. M. Taylor. *Phil. Mag.* 6. *pp.* 88–97, *July*, 1928.

The apparatus described in *Roy. Soc., Proc.* 125. p. 589, 1925, has been

used to show that infra-red rays are partially polarised by transmission through thin plates of calcite cut parallel to the optic axis, and such polarisation effects have been used to determine which of the bands observed in the absorption spectrum of calcite really correspond to the maximum of absorption and which are merely spurious and due to interference effects. It is suggested that the spectrum can be explained without assuming the inactive frequency to be active in combination.

W. H. Ge.

2999. Influence of Boric Acid on the Dispersion of Certain Optical Glasses in the Infra-Red. T. Dreisch and P. Lueg. *Zeits. f. Phys.* 49. 5–6. *pp.* 380–385, 1928.

In the visible spectrum, and for wave-lengths less than 1μ, borate glasses have a relatively small dispersion. This, however, increases rapidly when the wave-length increases beyond 1μ, and soon becomes greater even than that of flint glass. This increase in the dispersion becomes greater with increased amount of boric acid in the glass, and is related to the strong absorption of boric acid for long wave-length infra-red radiations. H. N. A.

3000. Apparatus for Measuring the True Angle of Optic Axes. C. Gaudefroy. *Comptes Rendus*, 186. *pp.* 877–878, *March* 26, 1928.

A direct method. A slice is cut parallel to the plane containing the axes and immersed in a liquid whose refractive index is greater than the mean index of the crystal. The slice is observed obliquely in convergent light. The transmitted beam is cut off sharply on each side by total reflection. The planes of incidence containing the optic axes are remarkable in this respect since the limiting angle of transmission have maximum or minimum values. The azimuth between the planes in which critical values exist for the limit of transmission gives the angle between the optic axes. Experimental details are given. J. E.

3001. Observations on the Fringes Obtained in Converging Light. C. Gaudefroy. *Comptes Rendus*, 186. *pp.* 1353–1354, *May* 14, 1928.

In a recent note [see preceding Abstract] mention was made of certain fringes calculated by Raveau [Abstract 1146 (1913)] in crystals. If one examines in convergent light a lamina parallel to the plane of the optic axis of a crystal, two sets of fringes are seen in the neighbourhood of a pole of an optic axis separated by the trace of the plane of axial refraction. Observations of these fringes in monochromatic light confirms the calculations of Raveau. J. E.

3002. Theory of Light. F. Wolfers. *J. de Physique et le Radium*, 9. *pp.* 170–174, *May*, 1928.

A discussion of supplementary fringes from the standpoints of classical and quantum theories. [See also Abstract 2370 (1928).] F. S.

3003. Proposed Experiment on the Nature of Light. D. M. Dennison. *Nat. Acad. Sci., Proc.* 14. *pp.* 580–581, *July*, 1928.

The suggestion is to allow a " monochromatic " beam of high-frequency X-rays to fall upon a crystal lattice, and to place two Geiger counters at

the positions of two Laue spots, the intensity of the beam to be adjusted so that only a few quanta would enter each of the counters in a minute. On the classical wave theory the absorptions at the two counters take place simultaneously, for any group of waves will be diffracted to all the Laue points simultaneously. On the quantum theory, on the other hand, the quanta entering the two counters are independent of one another, and enter in general at different times. H. N. A.

3004. Resolving Power and Contrast. O. Sandvik. *J.O.S.A. and R.S.I.* 16. *pp.* 244–258, *April*, 1928. *Comm. No.* 334 *from the Kodak Research Lab. Phot. J.* 68. *pp.* 313–324, *July*, 1928.

The resolving power of a photographic material is defined as the ability to show fine detail in the picture. If defined numerically, as the number of lines and spaces per millimetre which it allows, then other factors will affect the resolving power as measured, among them the contrast in the object. In this paper the dependence of the resolving power on the contrast in the object is measured, defining contrast as the ratio of the photographic intensities of contiguous small areas. The method was to photograph in a reducing camera a series of parallel line test objects differing in contrast, and then to determine the maximum resolving power for the respective objects by microscopic examination. It is found that the resolution changes very rapidly with contrast at low contrast values. Zero at contrast of unity, it reaches 76 % of its maximum at a test-object density of 0·6, *i.e.*, a contrast of 4. It reaches its maximum at a contrast between 100 and 320. A. C. M.

3005. Gratings. G. Simon. *Comptes Rendus*, 187. *pp.* 111–112, *July* 9, 1928.

Directions for making superposed gratings by contact on a daguerreotype silver plate. A. D.

3006. Transmission of Translucid Diffusing Spheres and the Principle of Conservation of Luminous Flux. A. Blondel. *Comptes Rendus*, 186. *pp.* 1781–1784, *June* 25, 1928.

Develops a formula for the total transmission of a diffusing spherical globe, considering specular and diffuse reflection, as well as absorption. The simple case, when the diffusion by reflection and transmission follows Lambert's cosine law, is first dealt with, the general case being afterwards considered. The formula obtained is a simple algebraical expression of the principle of conservation of luminous flux, which can be of extreme value in photometry. R. C. F.

3007. Fluorescence of Mercury Vapour. H. Niewodniczanski. *Zeits. f. Phys.* 49. 1–2. *pp.* 59–72, 1928.

The line λ1849 Å. mentioned in a former short note is not confirmed. The spectrum of fluorescing mercury vapour heated to 245°–910° and excited by the Al spark was investigated. The band with the intensity maximum at about 3300 Å. shows a quite different intensity distribution from the other bands. By addition of hydrogen all the lines and bands are weakened, except the one with the long wave-limit of 2349 Å., whose intensity is unaltered. From the distribution of intensities the origins of the bands are deduced. The band with the long-wave limit at 2349 Å. was studied with saturated mercury vapour, and the conclusion reached

that the decrease of intensity with increasing vapour pressure is due to increasing band absorption. J. E.

3008. Extinction of Mercury Vapour Fluorescence by Addition of Gas. O. Oldenberg. *Zeits. f. Phys.* 49. 9–10. *pp.* 609–618, 1928.

While at room-temperature the fluorescence of mercury vapour is not appreciably more altered by addition of oxygen than by argon, at 750° C. oxygen is quite inactive, while argon is very effective. Possibly this peculiarity of oxygen is due to the equality of a resonance frequency with the change $2^3P_0 \rightarrow 2^3P_0$ of mercury. The extinguishing effect of argon increases at 750° C. to something like fivefold. [See also Abstracts 2077 (1925), 2604 (1926).] J. E.

3009. Spectroscopic Study of the Luminescence Excited by γ-Rays in Water and Carbon Bisulphide. L. Mallet. *Comptes Rendus*, 187. *pp.* 222–223, *July* 23, 1928.

Previous work [see Abstract 2599 (1926)] had indicated that this luminescence extended into the ultra-violet. The luminescence has now been examined with a newly designed spectrograph of large aperture. Using a source of 250 mgm. radium, photographs are obtained with 2–4 days' exposure. The β-rays are stopped by 2 mm. of lead, and precautions are taken to prevent direct action of the γ-rays on the photographic plate. With both water and carbon bisulphide, the spectra are continuous throughout the range of wave-lengths transmitted by the optical system (down to 3700 Å.). No measurements have been made of the distribution of energy in the spectra, but comparison spectrophotographs show that the γ-ray luminescence of both liquids is relatively richer in rays of short wave-lengths than the direct radiation from a " gas-filled " electric light bulb. H. R. R.

3010. Pressure of Light on Uncharged Submicroscopic Particles in the Electric Field. G. Placzek. *Zeits. f. Phys.* 49. 7–8. *pp.* 601–603, 1928.

Tests were made with particles of Se, Fe, Ag, Hg, S and oil of such a size that the rate of fall is almost negligible. The space between the condenser plates could be illuminated by diffuse or concentrated light. The particles may move with or against the electric field, and the direction of travel is independent of the wave normal to the electric field. For constant illumination the velocity of motion increases with the field strength, but more slowly. The effect of the shape of the particles is uncertain. Ultra-violet light was ruled out as the cause, radiometer action being considered the probable cause. Further tests are needed with determinations of the velocity, the effects of field strength, radiation intensity and pressure, and the nature of the surrounding gas to establish any conclusions. [See Abstract 1085 (1918).] R. S. R.

3011. Rydberg Term Tables. F. Paschen. *J.O.S.A. and R.S.I.* 16. *pp.* 231–243, *April*, 1928.

J. R. Rydberg calculated a table of values of $N/(m + a)^2$ to be used in the analysis of spectral series. For spark spectra it is useful to have tables of values of $Z^2N/(m + a)^2$, where Z is 2, 3 . . ., etc. The present work is a collection of tables up to $Z = 4$, together with examples of their use. A. C. M.

3012. Width of Balmer Lines. (Miss) M. Hanot. *J. de Physique et le Radium*, 9. *pp.* 156–169, *May*, 1928.

This paper is largely a recapitulation of an earlier one [see Abstract 916 (1928)]. F. S.

3013. Continuous Spectrum of Hydrogen. Y. Takahashi and Y. Hukumoto. *Tohoku Univ., Sci. Reports*, 17 *pp.* 675–678, *June*, 1928. *In English.*

The intensities of the spectrum from a discharge tube have been compared at atmospheric temperature and at that of liquid air. The continuous spectrum, especially near 2300 Å., is enhanced on cooling, while the secondary spectrum and Balmer's series lines are reduced. F. S.

3014. Stark Effect of the Fine Structure of Hydrogen. R. Schlapp. *Roy. Soc., Proc.* 119. *pp.* 313–334, *June* 1, 1928.

The influence of an electric field on the fine structure of the levels of the hydrogen atom is investigated, using the wave-equations of Darwin and Dirac. In weak fields all the fine-structure levels, except the highest, split up into several, with separations proportional to the first power of the field; in the highest level the separations are proportional to the square of the field. In stronger fields, the fine structure of each of the equidistant levels of the ordinary Stark effect is found. In weak fields the fine-structure components of the lines are expected to show a Stark effect in which some of the separations are proportional to the first power of the field, while in stronger fields each Stark component will have a simplified structure. Hα is worked out in detail. A. C. M.

3015. Red Hydrogen Line in the Positive Column. E. Lau. *Zeits. f. Phys.* 48. 11–12. *pp.* 824–830, 1928.

Hα is investigated, using the method of two Lummer-Gehrcke plates in series, each silvered on the top surface [see Abstract 892 (1928)]. It is found that there are differences parallel and perpendicular to the electric field of the positive column. The distance between the two components as measured by the distance between the maxima of blackening on the photographic plate is $0 \cdot 14_5$ Å.U. with the direction of polarisation perpendicular to the electric field, and $0 \cdot 13_6$ parallel thereto, at a pressure of $0 \cdot 3$ mm. At a pressure of $0 \cdot 05$ mm., the distance apart was $0 \cdot 14_5$ Å.U., independent of field direction. It is suggested that the experiments show a dependence of the form of Hα upon the direction of the impinging electrons. A. C. M.

3016. New Regularities in the Band Spectrum of Helium. Part I. G. H. Dieke, T. Takamine and T. Suga. *Zeits. f. Phys.* 49. 9–10. *pp.* 637–669, 1928.

A series of new helium bands are described, all having the $2p$ term as final term, and initial terms x, y, z, the properties of which deviate considerably from those of previously known terms. Corresponding ortho- and para-bands show analogous structure. In addition a number of new vibration bands are reported, some with $n = 2$. Tables of measured wave-lengths in the bands are reproduced and the constants of the vibration bands computed. W. S. S.

3017. Broadening of HCl Rotation Lines by Foreign Gases. H. W. Kussmann. *Zeits. f. Phys.* 48. 11–12. *pp.* 831–844, 1928.

Absorption measurements were made by the method of two quantz lenses of Rubens and Wood on the broadening of the rotation lines in the spectrum of HCl by admixture of different foreign gases (N_2, CO, A and H_2). In spite of the high degree of symmetry of the argon atom, this gas was found to have a marked effect. Consequently it was concluded that the broadening is due in the main not to an intramolecular Stark effect, but to a disturbance due to collision with the foreign atoms (Lorentz theory). Accordingly the change in absorption for any particular foreign gas, brought about by the broadening, will be proportional to the increase in the number of collisions per second. But no proportionality was found between number of collisions and change in absorption. Consequently it is suggested that the Lorentz formula for the half-width of the line must be altered so as to contain a constant factor, which the author calls the " optical collision factor," different for the different gases.

A. C. M.

3018. Recent Progress in Theory of Band Spectra. E. C. Kemble. *Frank. Inst., J.* 206. *pp.* 27–42, *July*, 1928.

The representation of band spectra by Fortrat and energy diagrams is described, and their interpretation on the Bohr-Sommerfeld theory discussed. The application of optical measurement to the determination of such quantities as the heat of dissociation of a molecule is then considered, together with Franck's explanation of photochemical dissociation. The application of wave mechanics to the interpretation of such spectra is then discussed.

F. S.

3019. Terms in the Band Spectra of the Oxygen Molecule. W. Ossenbrüggen. *Zeits. f. Phys.* 49. 3–4. *pp.* 167–216, 1928.

The purpose of this work is to assign terms in the band spectra of the neutral oxygen molecule. The bands considered in the ultra-violet were the Schumann bands, the Runge bands and the Füchtbauer bands. Terms were found for the last two sets of bands; the accuracy of the measurements in the case of the Schumann bands would only permit of showing their connection with the other bands. Terms were also ascribed to the " atmospheric oxygen bands," which have a term in common with the Schumann bands. The moment of inertia of the oxygen molecule in the unexcited state, free from vibration, is calculated to be $19{\cdot}20 \times 10^{-40}$ gm. cm.^{2} and the atomic distance to be $1{\cdot}201 \times 10^{-8}$ cm.

A. C. M.

3020. Intensities of Spectral Lines. A. Kupper. *Ann. d. Physik*, 86. 4. *pp.* 511–529, *July* 10, 1928.

The intensities of hydrogen series lines (Lyman, Balmer, Paschen, Brackett and 5th series) are calculated in spatial polar coordinate, using wave-mechanics. The results are compared with the series spectra of the alkalies, since hydrogen itself is subject to very great changes in intensity distribution, dependent upon the excitation conditions. A table of amplitude squares is given.

A. C. M.

3021. Band Spectra of Mercury. (Lord) Rayleigh. *Roy. Soc., Proc.* 119. *pp.* 349–357, *June* 1, 1928.

A continuation of experiments previously described [see Abstract 644

(1928)]. A mercury band spectrum is described which is excited by fluorescence, with the continuous hydrogen spectrum as a source. The spectrum shows the band 2540 in emission, without the resonance line 2537 being present. The continuous spectrum on the short-wave side of the bands at 2345, 2338, etc., extends as far as 2150, and thus much beyond the position of the forbidden line $1^1S_0 - 1^3P_2$, 2270, which was found under other conditions to limit this continuous spectrum. The series of bands 2345, 2338, etc., is examined in emission with large resolving power. It is found to be free from the complications of a finer underlying structure which appear in absorption. A remarkable structure is found in the band 2482 to 2476, described by earlier writers as continuous; the structure is difficult to describe in terms of quantum theory. It does not appear in absorption. A. C. M.

3022. Intensities of Mercury Lines under Different Excitations. T. Hori. *Zeits. f. Phys.* 49. 3–4. *pp.* 259–268, 1928.

A comparison of spectrograms of mercury taken under different conditions of excitation allows a qualitative comparison of the intensities of arc lines of mercury. It is shown qualitatively that the share in the light of each single line is in a great measure dependent upon the voltage velocity of the impinging electron, and consequently that the voltage giving rise to the maximum share must be far from or near to the critical voltage according to the magnitude of the quantum numbers n, l, s, j. In the *Discussion*, a suggestion arises that the intensity of a spectral line is fixed by the product of the number of atoms in the initial state and the transition probability, where this latter is a fixed atomic property. [See also next Abstract.] A. C. M.

3023. Intensities of Mercury Lines under Different Excitations. E. Fues. *Zeits. f. Phys.* 49. 3–4. *p.* 269, 1928.

A correction to a remark made in conversation with T. Hori, and included in his paper [see preceding Abstract]. An exact calculation of the collision transition probability does not fit in with a controlling influence on the intensity relations in multiplets by the magnitude of the velocity of the electrons which by their collision give rise to the excitation. On the contrary, it will be shown in a later paper that the direction of the collision relative to the atom alone gives a possibility of selecting the " states " of a multiplet. A. C. M.

3024. Spectroscopic Investigations on the After-Glow in Nitrogen. G. Herzberg. *Zeits. f. Phys.* 49. 7–8. *pp.* 512–533, 1928.

(1) It is shown that although the ordinarily observed spark and arc lines of nitrogen are not related to the after-glow, the spectrum of the discharge giving rise to this latter always contains the red and infra-red arc lines particularly well marked. In a discharge just not giving the after-glow, these lines do not occur. This accords with Sponer's view that the after-glow arises in the recombination of N-atoms in triple collisions. (2) At liquid-air temperature the intensity maximum in the green, yellow and red band groups in the after-glow is displaced considerably towards the violet. A displacement in the opposite direction occurs with increased pressure and for a longer interval between the excitation discharge and the observation. (3) The structure of the CN bands observed in the after-glow is discussed and shown to present a

parallel to the resonance fluorescence of iodine. (4) The evidence for and against Sponer's explanation of the after-glow is collected and it appears that most facts are in favour of Sponer's view. W. S. S.

3025. Structure of the Negative Nitrogen Bands. G. Herzberg. *Ann. d. Physik*, 86. 2. *pp.* 189–213, *June* 15, 1928.

These bands were investigated by the electrodeless discharge in nitrogen at very low pressure. Under these conditions the negative bands appear in very great purity, so that the band lines are not overlaid by other bands. This made it possible to follow the band groups (Δn = constant) right to the theoretically expected reversal point, not previously observed, and beyond. The band heads are arranged in a diagonal scheme. Tail bands (Schwanzbanden), analogous to those already found in the cyanogen bands, are shown to occur in connection with those bands, and also are shaded to the red. These also can be considered as bands of high n', on the other side of the reversal point, and then fit well in the band-head scheme. This (shading) reversal point does not coincide with the reversal point already found. The appearance of the tail bands makes it probable that N_2^+ can be dissociated at high electron velocities in one single elementary process. Some of the band heads are double; this is attributed to disturbances caused by the bands for which $n' = 1$. A. C. M.

3026. Absorption Spectrum of Nitric Oxide. M. Lambrey. *Comptes Rendus*, 186. *pp.* 1112–1114, *April* 23, 1928.

See also Abstract 3120 (1927).

3027. Absorption Spectrum of NO. M. Lambrey. *Comptes Rendus*, 187. *pp.* 210–212, *July* 23, 1928.

Curves are given connecting the wave-length and the optical density of a layer of 1 cm. of the gas at N.T.P. Formulæ are given for the doublets λλ2267, 2261 Å. and λλ2153, 2148 Å. F. S.

3028. Influence of Different Nuclei on the Absorption Spectra of Organic Compounds. J. E. Purvis. *Cambridge Phil. Soc., Proc.* 24. *pp.* 421–425, *July*, 1928.

Observations were made of the absorption spectra of a number of substances derived from aniline, *o*- and *m*-cresols, and α- and β-naphthylamines. The results show that in the phenyl derivatives of the two naphthylamines the introduction of the C_6H_5-group produces an additional band; that in the *ar*- and *ac*-hydrogen derivatives of these two compounds the type of absorption is controlled by the saturated or unsaturated condition of each constituent ring; that in the cresols the introduction of a NO-group produces colour; and that in the anilides the position of the typical absorption of aniline is destroyed, and it is replaced by a band due to a C_6H_5-group. W. S. S.

3029. Continuous and Band Spectra of Zinc Vapour. H. Volkringer. *Comptes Rendus*, 186. *pp.* 1717–1719, *June* 18, 1928.

The spectrum of zinc vapour enclosed in a silicon tube and excited by the electrodeless discharge is described, as the temperature is increased from a value just sufficient to yield the arc and spark spectra. For low

densities of vapour a continuous spectrum apparently related to the line spectrum is obtained, which is attributed to free electrons of various kinetic energies entering orbits and to electrons passing from one orbit to another emitting non-quantised radiation. For higher densities a band spectrum is given, which can be attributed to radiation from unstable molecules formed of zinc atoms, some of which are excited. W. S. S.

3030. Kathodo-Phosphorescence of Erbium in Calcium Oxide. S. Fagerberg. *Ann. d. Physik*, 86. 3. *pp.* 435–446, *June* 30, 1928.

The spectrum consists of a number of characteristic line groups extending over the range 6800–3100, with fairly large intervals. Besides these there are more or less sharp bands. It is unlikely that the spectrum can be an oscillation series; it is more probably a multiplet series. The ordinary phosphorescence gives only a wide and diffuse band between 4100 and 3600. J. E.

3031. Intensity Ratios in Ortho- and Para-Series of Helium. J. Stark. *Ann. d. Physik*, 86. 4. *pp.* 530–540, *July* 10, 1928.

Helium possesses a system of singlets (para-series) and a more complex system (ortho-series). The principal, sharp and diffuse series are known of both systems, of second order—*i.e.*, $2S-mP$, $2s-mp$, $2P-mS$, etc. The ortho-terms are always slightly greater than the corresponding para-terms. The author regards the structure of the para- and ortho-helium atoms as precisely the same, but in the ortho-atom the direction of the magnetic moment of one electron is opposed to the magnetic field of the ion, while in the para-atom it is in the same direction. Thus in the ortho-atom the electrons are closer to the nucleus, so that the terms corresponding to states of the ortho-electrons will be greater—*i.e.*, deeper levels. From this, combined with the fact that helium is diamagnetic, is deduced the fact that the deepest term will be a para-IS term, and that the corresponding ortho-I*s* term cannot exist. Lyman has observed a principal series $IS-mP$, but no corresponding ortho-principal series $Is-mp$. The author consequently looked for such lines, using helium canal rays and a vacuum-grating spectrograph. The H-line 1216 Å.U., and the para-He lines I*s* - 2P (584 Å.U.) and IS – 3P (537 Å.U.) appeared in the first and second order, but no other lines of greater intensity than the para-lines which could be ascribed to helium. Also the possible line $Is-IS$ was searched for but not found. In another series of experiments the relative intensities of the para- and ortho-lines under different conditions were investigated. It was found that in the positive column the intensity ratio of para- to ortho-series lines is smaller the higher the gas pressure, and also that the falling off in intensity along a series increases with increasing pressure. This is made to account for the changes in colour of the gas discharge with pressure changes. According to the author's theory, emitting helium atoms which are moving the intensity ratio of para- to ortho-lines should be less than in the case of helium atoms at rest. This is found to be the case by comparing the spectrum of H-positive rays incident in helium with He-positive rays incident in hydrogen. It is also shown that the intensity ratio para to ortho is greater, at the same pressure, for fast kathode rays than for slow kathode rays or for positive rays. The para-series of helium are held to correspond to the alkaline-earth singlets, the ortho-series to the triplets.

A. C. M.

3032. Polarisation of Cadmium Resonance Radiations. P. Soleillet. *Comptes Rendus*, 187. *pp.* 212–214, *July* 23, 1928.

The previous work [see Abstract 3121 (1927)] has been repeated with improved apparatus, in which the effect of impurities has been avoided. Some results have also been obtained for the line 2288 Å. F. S.

3033. Elimination of the Doppler Effect in Spectroscopic Fine Structures and the Exact Determination of the Components. G. Doetsch. *Zeits. f. Phys.* 49. 9–10. *pp.* 705–730, 1928.

Two methods are given for determining the components of the fine structure when, owing to the broadening of each of them due to the Doppler effect, they have merged into one another in such a way that the intensity curve shows little, if any, direct effect due to the individual maxima. The first is a direct mathematical method for resolving any function into a series of Gauss "error" or "cocked-hat" curves, each of which then represents the effect of one of the component broadened lines of the fine structure. The author in 1926 gave a solution of a heat problem by means of which the thermal condition of an infinitely long bar can be followed backward in time to an initial state, and he applies the result to the present problem, which is to find the position of the lines of the fine structure when there are no thermal movements of the atoms. Both methods are applied to intensity measurements of the Hα line, and it is proved that there are at least three components—a fact which Hansen deduced qualitatively from his measurements, and Sommerfeld and Unsöld have assumed in their theory. H. N. A.

3034. Spark Spectra of Germanium. K. R. Rao and A. L. Narayan. *Roy. Soc., Proc.* 119. pp. 607–627, *July* 4, 1928.

The spark in hydrogen between germanium-tipped electrodes has been photographed with a 5-ft. concave grating and a large quartz spectrograph. The classification into stages of ionisation was done by changing the self-induction or capacity in the circuit. Thirteen terms are found in the spectrum of GeII (doublets), nineteen in the spectrum of GeIII (triplets and singlets), and six in the spectrum of GeIV (doublets).

A. C. M.

3035. Intensity Ratio of the Principal Series Doublets of the Alkali Metals. H. Jakob. *Ann. d. Physik*, 86. 4. *pp.* 449–493, *July* 10, 1928.

After a review of previous researches on the intensity ratio of doublets, experimental determinations of this ratio for the principal series doublet two of potassium, cæsium and rubidium, are described. Using the photographic-photometric method of Merton with an oxy-hydrogen flame impregnated with the salt, it is found that the intensity ratio for the potassium doublet has values between 1·80 and 2·02, dependent on the concentration of the solution through which the gas is passed. Merton's method of using a wedge crossed with horizontal lines on an opaque ground is also discussed and improved upon. Further results, using Gouy's method of simultaneous measurement of emission intensities and total absorptions, are obtained for the rubidium and cæsium doublets. The true intensity ratio for rubidium cannot definitely be fixed, but is above 2·3, whilst the value for the cæsium doublet is shown to be approximately 4·0. [See Abstract 1005 (1927).] R. C. F.

3036. Regularities Exhibited between Certain Multiplets for Elements in the Second Long Period. R. C. Gibbs and H. E. White. *Nat. Acad. Sci., Proc.* 14. *pp.* 559–564, *July*, 1928.

The regular displacement of multiple levels and of multiplets found to hold well for sequences of iso-electric atomic systems in the first long period have now been extended to the elements in the second long period. [See Abstracts 2544 (1927) and 1930 (1928).] W. S. S.

3037. Optical Stimulation and Dissociation. K. Butkow and A. Terenin. *Zeits. f. Phys.* 49. 11–12. *pp.* 865–884, 1928.

An expansion of a former investigation [see Abstract 113 (1928)] to the cases of CsI, TlBr, TlCl and CuI. The dissociation heats are calculated out; they agree with the thermoelectrical data. Besides the atomic lines TlI also emits a molecular band-spectrum under the impact of light. The level-scheme of TlI is brought into relation with various dissociation-processes. TlI is in its gaseous state an atomic compound. A. D.

3038. Dispersion of Long Wave-Length X-rays in Platinum and Calcite. E. Dershem. *Nat. Acad. Sci., Proc.* 14. *pp.* 380–384, *May*, 1928.

A vacuum apparatus is described for producing a nearly monochromatic beam of X-rays, and determining for any surface the maximum angle of incidence at which reflection of the X-ray beam takes place. From this critical angle of total reflection, the refractive index μ of the substance forming the surface is determined. The results show that for platinum $(1 - \mu)$ increases with the wave-length λ of the X-rays in the range 1 to 7 Å.U. For calcite, over the same range the curve $1 - \mu$ against λ shows a characteristic kink corresponding to anomalous dispersion near the K absorption limit of calcium. Fuller account to be published elsewhere. W. S. S.

3039. Quantitative X-Ray Analysis with Cold Excitation. R. Glocker and H. Schreiber. *Ann. d. Physik*, 85. 8. *pp.* 1089–1102, *May* 24, 1928.

It is shown that with cold excitation of a substance by radiation with X-rays, the usual methods of X-ray analysis can be employed with the avoidance of errors due to alteration of concentration of the substance. The relation between the intensities of the lines due to two elements and the tube voltage and the amount of foreign substance was investigated practically and theoretically. It was found that, exciting the spectrum by X-rays, the general use of quantitative X-ray analysis is quite possible. By the Debye method the alteration of concentration of a substance in the antikathode first noticed by Coster [see Abstract 2432 (1923)] and Nishina could be followed. J. E.

3040. X-Ray Examination of Liquids. D. Coster and J. A. Prins. *J. de Physique et le Radium*, 9. *pp.* 153–155, *May*, 1928.

An X-ray tube is described which can be oscillated about a horizontal axis coincident with that of a small cylindrical camera attached to it. By this means a liquid surface can be used as a crystal in a similar way to that used by Bragg for crystal powders. The apparatus was tested with a plate of lead and experiments with mercury are described. F. S.

3041. Thermoluminescence Excited by X-Rays. Further Experiments upon Synthetically Prepared Materials. Frances G. Wick and Mabel K. Slattery. *J.O.S.A. and R.S.I.* 16. *pp.* 398–408, *June*, 1928.

Experiments have been made with sulphates of Cd, Ca, Na and Zn, containing a small amount of manganese. X-rays cause two kinds of change, a thermoluminescence appearing very quickly on heating, and lasting a very short time, and another which grows slowly and lasts longer. The first effect disappears in a few hours if the substance is left at room-temperature after exposure, while the second may last for months; at liquid air temperature both effects last indefinitely. The decay of thermoluminescence was studied under varying conditions. Ultra-violet light of a certain frequency suppresses the effect due to X-rays. The results are compared with those of Wiedemann and Schmidt, using kathode rays. H. N. A.

3042. New Method of Spectroscopy for Faint X-Radiations. P. A. Ross. *J.O.S.A. and R.S.I.* 16. *pp.* 433–437, *June*, 1928.

Foils of two adjacent elements (silver-cadmium, palladium-silver, platinum-gold) are placed alternately in the X-ray beam. The thicknesses are adjusted so that the transmission curves of the two foils coincide, except between their K discontinuities. The X-rays pass into an ionisation chamber, and the difference between the ionisations produced with the two foils is measured; this difference is due to the band of X-radiation lying between the two K absorption limits. The final adjustment of effective thickness of the foils is made by inclining one of them slightly to the X-ray path. It is shown that the " advantage " of this method, as compared with the ordinary crystal method of X-ray spectroscopy, may be made more than one-thousand for the same degree of monochromatisation. It is also possible in certain cases to use thin layers of salts, when metal foils cannot be produced, though the non-metallic constituents of the salts cause difficulties, which, however, can be overcome in some cases. H. N. A.

3043. Polarisation of X-Rays from a Tungsten Target. P. A. Ross. *J.O.S.A. and R.S.I.* 16. *pp.* 375–379, *June*, 1928.

Uses the author's new method of X-ray spectrum analysis [see preceding Abstract]. The X-rays from the target passed upwards through a hole in a lead glass plate, and were scattered horizontally through a line of slits, in which the Cd and Ag foils could be in turn interposed; readings of the ionisation current produced were taken by means of a modified Compton electrometer. The kathode stream was set at right angles to the scattering plane, and the difference in reading with the two foils was taken as recording the intensity of the band of radiation between 0·4850 Å. and 0·4632 Å. The X-ray tube was turned through 90° about a vertical axis and the readings were repeated, giving the intensity with the kathode stream parallel to the scattering plane. The polarisation $P = (I_1 - I_2)/(I_1 + I_2)$ was approximately zero for exciting voltages above about twice the quantum voltage of the wave-length band studied; it increased rapidly towards unity as the applied voltage approached the quantum voltage. H. N. A.

3044. Fine Structure in the Copper and Nickel K-series. H. Purks. *Phys. Rev.* 31. *pp.* 931–939, *June*, 1928.

High resolving power was gained by using the double X-ray spectro-

meter previously described [see Abstracts 1298 and 1299 (1928)]. With wide slits lines could be studied after second order reflection from two calcite crystals. At 40 kV and in the first order the widths at half-maximum of the lines (in X.U.) were NiK$\alpha_{1,2}$, 0·66; CuK$\alpha_{1,2}$, 0·63; MoK$\alpha_{1,2}$, 0·47; AgK$\alpha_{1,2}$, 0·43; MoK$\beta_{1,2}$, 0·43; AgK$\beta_{1,2}$, 0·40. Structure in the lines of Ni and Cu was clearly shown by the shape of the curves. Lack of symmetry could be explained by the presence of weak lines on the long wave-length side. The Kβ doublets of Mo and Ag were clearly resolved after first order reflection, while those for Ni and Cu were not resolved after second order reflection; but the components could be deduced in intensity and position from the shapes of the curves. The widths of the Kα lines varied with voltage applied; they increased with increasing voltage, to a limiting value near to 40 kV. This change is attributed to the successive appearances of spark lines. A. C. M.

3045. Atomic Scattering Power for X-Rays from Powders of Gold, Silver and Aluminium for CuKα Radiation. J. Brentano. *Phil. Mag.* 6. *pp.* 178–191, *July*, 1928.

A description is given of experiments the object of which was to obtain comparative values for the scattering power of gold, silver and aluminium. The measurements were made with small powder particles, and in the method employed the intensities were measured from composite layers. This method is discussed in the paper. An important factor amongst those which determine the intensity of X-ray reflections is the quantity F which is defined as the effective negative charge of the atom, which, situated at its centre, would be equivalent to the actual charge distributed in space for scattering radiation of the particular wave-length at the particular glancing angle θ. The results of the experiments indicate that for the elements of high atomic weight examined in the state of very fine powders the scattered intensities increase considerably less rapidly than F^2 and that better agreement is obtained by assuming the scattered intensity proportional to F. J. J. S.

3046. Emission of Secondary Electrons and the Excitation of Soft X-Rays. O. W. Richardson. *Roy. Soc., Proc.* 119. *pp.*531–542, *July* 4, 1928.

First reviews existing data [see Abstract 2932 (1927)]. At low voltages the effect of a beam of electrons on a target is pure reflection; at higher voltages this persists as a Davisson reflection, but with a continuously diminishing proportion of secondary electrons by reflection. This paper is concerned with the mode of origin of the increasing proportion of secondary electrons not due to pure reflection. Evidence is cited for the belief that discontinuities in secondary electron emission and the production of soft X-rays are coincident. After a consideration of possible mechanisms, it is concluded that the primary electron is converted into a soft X-ray of equivalent energy; that this ejects an electron of corresponding energy which again can eject electrons of smaller energy. There is approximately one secondary electron for each primary, and in the case of the photoelectric action of soft X-rays one electron for each quantum. In each case, however, the average energy is much less than the incident energy. A calculation is made of the expected intensity of the secondary beam. According to the scheme suggested, a primary electron produces nearly the same number of soft X-ray quants as secondary electrons. The

small X-ray efficiency is due to their abnormal absorbability near the point of origin. The efficiency of X-ray excitation is of the order 10^{-6} and of photoelectric action and secondary emission unity. J. E.

3047. Refractive Index of Glass for X-Rays of Long Wave-Length. J. Thibaud. *Comptes Rendus*, 187. *pp.* 219–221, *July* 23, 1928.

Discrepancies between wave-lengths of soft characteristic X-rays, as measured by reflection from crystals and ruled gratings respectively [see Abstract 917 (1928)] are attributed to a refractive index for these rays appreciably less than unity. The measured anomalies are in fair accord with theory. This is further tested by measurements of the extent of the range of angles in which the grating gives total reflection for wave-lengths between 17 and 65 Å.U. (iron L; oxygen, nitrogen and carbon K; and molybdenum M rays). The limiting angle of total reflection cannot be measured very accurately on account of the complications introduced by the intense absorption of soft X-rays in glass. The tabulated results of the measurements are in approximate agreement with the Drude-Lorentz formula, and show the expected type of variation of refractive index with wave-length. H. R. R.

3048. Spectrum of X-Rays from the Back of a Tungsten Target. E. Lorenz. *Nat. Acad. Sci., Proc.* 14. *pp.* 582–588, *July*, 1928.

Describes a special form of X-ray tube for investigating the effect of the secondary electrons, which are emitted from the anode when it is bombarded by the primary electrons from the kathode. These secondary electron rays are bent backward by the positive field of the anode and by the negative field from the glass walls, and strike the anode, producing additional X-radiation. The distance between the anode and the kathode, which consisted of a heated tungsten filament, was small, so that the primary electrons struck only the back of the anode and not the front, the X-radiation from which was measured. Voltages ranging from 22,400 to 82,500 were employed, and the ionisation currents produced by the "secondary" X-rays, "stem radiation," were measured as a function of the crystal angle of the Bragg spectrometer. The same was done with the X-rays from the focal spot. Curves were plotted showing the relation between the ionisation current and the grazing angle of incidence for both cases; the differences between the voltages obtained from the limit of the focal spot radiation and from the limit of the stem radiation were 2650 for excitation voltage as measured by an electrometer, 22,480; 3400 for 36,600; 4500 for 49,350; 8100 for 71,600; and 10,750 for 82,500. The author concludes that hardly any absorption of primary electrons takes place in any level of the tungsten atoms if the energy of the primary electrons exceeds that of the level by about forty times. H. N. A.

3049. Absolute X-Ray Wave-Length Measurements. A. P. R. Wadlund. *Nat. Acad. Sci., Proc.* 14. *pp.* 588–591, *July*, 1928.

The method is similar to that of Compton and Doan rather than to that of Thibaud. The line to be measured is reflected by a calcite crystal through a slit on to a grating, and the refracted beam falls on a photographic plate; the grating is then turned through approximately 180°, and the refracted beam photographed in its new position on the plate. A beam of light passes through a lens, falls on a plane parallel mirror which rotates with the grating, and an image of the source is formed on

another photographic plate, an exposure being made for each of the two positions of the grating. In this way the exact relation between the two positions of the grating can be recorded and the wave-length of the X-ray determined. H. N. A.

RADIOACTIVITY.

3050. Artificial Disintegration of Elements. H. Pettersson and G. Kirsch. *Arkiv f. Mat. Astron. och Fysik, Stockholm,* 20. *No.* 16. *pp.* 1–42, 1927.

Contains an account of the differences between the results obtained in Cambridge and in Vienna, together with the explanations given by the authors for the same. The question has been treated by them in papers appearing elsewhere. H. N. A.

3051. Action of α-Particles on Colloidal Gold Solutions. J. E. Maisin. *Ann. Soc. Sci. de Bruxelles,* 48. *pp.* 48–53, *June* 21, 1928.

Describes the effects observed when the ruby-coloured colloidal gold solutions are submitted to the action of α-particles from radon. With small quantities of radon no effect can be observed on the normal colloidal solution. When the solution is sensitised with a little potassium chloride, the colour changes to blue in one to two hours, whilst complete bleaching occurs after forty hours. Also, a black spongy precipitate is found at the bottom of the tubes containing the solutions. A decrease in the Tyndall effect is observed, the lateral light being almost completely polarised at the beginning, whilst after two days it is considerably diminished and only slightly stopped by a Nicol. Using a larger quantity of radon, with a diluted unsensitised solution, a quick action takes place. This gives a method of examining the change in the Tyndall effect, and the author describes the apparatus used for this part, clearly showing its advantages. From the results obtained, the diminution of the Tyndall effect increases slowly at first, then remains almost stationary, and afterwards rises rapidly. It appears as though the flocculation passes through two periods—a preliminary period of a latent state and a period of true flocculation. R. C. F.

HEAT.

3052. Heat Transference in a Flowing Liquid in a Tube. L. Prandtl. *Phys. Zeits.* 29. *pp.* 487–489, *July* 15, 1928.

The author supplements a formula given previously by him for the heat transference between a liquid flowing in a tube and the walls of the tube, in the light of later researches on the subject and on the characteristics of the flow of turbulent liquids. J. J. S.

3053. Device for Controlling the Rate of Cooling and Heating of the Haughton-Hanson Thermostat. J. D. Grogan. *Journ. Sci. Instruments*, 5. *pp.* 217–219, *July*, 1928.

The Haughton-Hanson thermostat consists of a silica bulb in an electric resistance furnace and attached to a mercury relay. Expansion of air in the bulb breaks the mercury relay, which in turn breaks or lowers the current heating the furnace. The device here described consists of an electrolytic cell which delivers oxygen to the thermostat bulb at a steady rate and produces a steady fall of temperature in the bulb. By diverting the gas to a counterpoise bulb attached to the other side of the mercury relay the temperature of the thermostat may be made to rise steadily.

AUTHOR.

3054. Micro-Apparatus for the Determination of Molecular Weight by the Cryoscopic Method. K. Iwamoto. *Tohoku Univ., Sci. Reports*, 17. *pp.* 719–722, *June*, 1928. *In English.*

Methods in use or proposed for the determination of the molecular weight of an organic substance in small quantities are briefly reviewed, and a record then given of satisfactory results obtained by the author using the ordinary method, but with a Beckmann thermometer of reduced size as in the case of Pregl's ebullioscopic process. H. H. Ho.

3055. High-Low Inversion of Quartz and the Heat Capacity of Low Quartz at 573° C. R. E. Gibson. *J. Phys. Chem.* 32. *pp.* 1206–1210, *Aug.*, 1928.

The high-low inversion of a crystal of quartz at one atmosphere pressure is a change of phase which is generally accompanied by superheating and super-cooling. There seems, however, to be a temperature ($572{\cdot}3 \pm 0{\cdot}2$) at which low quartz may be converted reversibly to high quartz, and, were it not for almost insuperable experimental difficulties, it would be possible to have the two phases in equilibrium at this temperature. Before a block of low quartz passes to the high variety it superheats so much that during the inversion its temperature never falls to the equilibrium value. Therefore, since the reaction is adiabatic, the apparent heat capacity of low quartz around 573° may be calculated. The value is 4 ± 1 cal. per gm. per degree. W. H. GE.

3056. Pressure Influence on the High-Low Inversion of Quartz. R. E. Gibson. *J. Phys. Chem.* 32. *pp.* 1197–1205, *Aug.*, 1928.

An experimental study in which it was found that when quartz is

subjected to a uniform hydrostatic pressure of p megabarges, the temperature of its high-low inversion is raised according to the equation: $\Delta T = -0{\cdot}3 + 2{\cdot}1 \times 10^{-2}p + 8{\cdot}6 \times 10^{-7}p^2$ over the range 0 to 3000 megabarges. From the initial pressure coefficient and the instantaneous volume change during the transformation it follows that the latent heat of inversion is 3·1 cal. per gm. W. H. Ge.

3057. Specific Heat of Nickel above the Curie Point. P. Weiss. *Comptes Rendus*, 187. *pp.* 12–14, *July* 2, 1928.

The atomic heat of nickel above the Curie point increases slowly, like that of copper. The difference for these two metals is constant. It appears probable that the increase in the specific heat is related to the change in the atomic magnetic moment. The calculations are based on data reduced from results by the author and others. [See Abstracts 1063 (1915), 2135 and 2203 (1928).] G. E. A.

3058. Prevalent Error in the Derivation of the Freezing-Point and Boiling-Point Laws for Dilute Solutions. A. W. Davidson. *J. Phys. Chem.* 32. *pp.* 1080–1085, *July*, 1928.

It is pointed out that the quantity of heat evolved at the temperature T_0 must include not only the heat evolved when the solvent freezes, but also the heat given out when the solvent is removed by osmotic work. The usual method of deriving the equation for the boiling-point law for dilute solutions omit a similar detail, which can be stated thus: Heat is given out during the osmotic removal of solvent in an amount equivalent to the osmotic work done upon the solution. The method of application of the correction was discussed, and it was pointed out that a similar method can be used for the approximate form of the freezing-point equation for ideal solutions. F. J. B.

3059. New Method of Measuring the Temperature of a Gas. M. Chopin. *Comptes Rendus*, 186. *pp.* 1830–1832, *June* 25, 1928.

The mass of a gas Q which flows through a small orifice is related to the difference of pressure p on the two sides of the orifice and to the absolute temperature of the gas T by the equation $Q = SK\sqrt{p/T}$, where S is the area of cross-section of the orifice and K is a constant for the given gas. An apparatus is described where this principle is utilised for the accurate measurement of gas temperatures. L. L. B.

3060. Temperature of the Oxy-Acetylene Flame. F. Henning and C. Tingwaldt. *Zeits. f. Phys.* 48. 11–12. *pp.* 805–823, 1928.

The temperature of the oxy-acetylene flame is measured by Kurlbaum's method of the reversal of spectral-lines, in the visible region and in the infra-red. The hottest point in the flame burning normally is about 3 mm. above the point of the luminous flame, and is there 3100° C. The measurements in the visible region could be applied to any part of the flame, but the infra-red measurements only to the outer parts of the flame. A. C. M.

3061. Second Order Inversion Point. W. Jazyna. *Zeits. f. Phys.* 49. 3–4. *pp.* 270–278, 1928.

On the basis of the experiments of Joule and Thomson, Vogel, Noell, and Natanson, it is found that assuming that the ideal state of a gas is

continuously approached as the gas is rarefied, there is an inversion point of the second order, given by $\left[\frac{\partial}{\partial p}\left(\frac{\partial \mathfrak{M}}{\partial p}\right)_T\right]_T = 0$. Also it is possible to give an explanation of the variability of the coefficient of expansion a_∞.

A. C. M.

3062. The Radiometer Problem. I. Bleibaum. *Ann. d. Phys.* **49. 7–8.** *pp.* **590–600, 1928.**

The theoretical results of Einstein, Hettner, Sterntal and Sexl are experimentally proved and demonstrated. The meaning of the radiometer effect as an edge effect for a definite range of pressure, in which gas currents may not exist, and for which the mean free path of the molecule is small in comparison with the size of the radiometer vanes and their distances from solid boundaries or enclosing walls, is fully vindicated. A series of other radiometer phenomena are also explained which otherwise cannot be proved, and the entire validity of the Einstein formula for the effect is proved.

S. G. B.

3063. Second Law of Thermodynamics in Chemistry. R. C. Cantelo. *J. Phys. Chem.* 32. *pp.* 982–987. *July*, 1928.

A theoretical paper wherein the author defines the second law as "heat cannot be converted into work without compensation," from which definition he is able to arrive at the familiar laws of physical chemistry and of chemical thermodynamics expressed in the form of mathematical equations.

J. K.

3064. Thermodynamics Based on Statistics. Parts I and II. G. N. Lewis and J. E. Mayer. *Nat. Acad. Sci., Proc.* 14. *pp.* 569–580, *July*, 1928.

Planck related the absolute entropy, not to the probability of a system, but to the total number of its possibilities. This view of Planck's has been the basis of all recent efforts to find the statistical basis of thermodynamics, and the authors now show it to be possible to derive the second law of thermodynamics in an exact form, and to obtain unambiguous definitions of the correlated quantities from simple statistical principles. It is assumed in the first part of the paper that for a system having a certain volume, energy and number of particles, the whole field of specifications which describes the states of the individual particles is naturally partitioned into regions in such a manner as to give unique significance to a quantity written as $\log \Omega$, where Ω represents the total number of recognisably different ways in which the particles may be distributed among the regions. This assumption includes within itself the second law of thermodynamics.

The second part of the paper gives a proof of these assumptions. A quantity S is defined by the equation $S = k \log \Omega$, where k is later identified with the Boltzmann constant. The quantities T and P are defined by the equations $\partial S/\partial E_v = 1/T$, and $\partial S/\partial V_E = P/T$, E being the energy and V the volume. These equations are identical in form with the essential equations of thermodynamics, and it is then shown that S, T and P are identical with the thermodynamical entropy, temperature and pressure. A third paper is promised, in which the actual mode of partition into regions in concrete cases will be examined, with some of the mathematical methods which may be used for the calculation of the absolute entropy.

T. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

3065. Relativistic Thermodynamics of Moving Electromagnetic Systems. T. de Donder. *Comptes Rendus*, 187. *pp.* 28-30, *July* 2, 1928.

The theory developed in a previous paper [see Abstract 2777 (1928)] is applied to the case of a moving electromagnetic system. Results embracing the Lorentz, Joule and Poynting effects and a generalisation of the Maxwellian force are deduced. J. S. G. T.

3066. Electron in a Gravitational Field. J. M. Whittaker. *Cambridge Phil. Soc., Proc.* 24. *pp.* 414-420, *July*, 1928.

(1) The expression obtained by Copson for the potential of an electric particle in a gravitational field [see Abstract 1672 (1928)] is substituted for V in the relativistic form of Schrödinger's wave equation given by Fock and others. The Einstein frequency shift is deduced directly without further assumption. (2) Electrostatics in the de Sitter "spherical" world are shown to be the same as ordinary electrostatics in a medium of dielectric constant $(1 - \mu r^2)^{-1}$, those in the Einstein "cylindrical" world being equivalent to ordinary electrostatics with dielectric constant $(1 - \mu r^2)^{-1}$; μ is a constant measuring the curvature of the world. W. S. S.

3067. Potential of Electromagnetic Phenomena in a Gravitational Field. E. T. Whittaker. *Roy. Soc., Proc.* 120. *pp.* 1-13, *Aug.* 1, 1928.

The Wiechert expressions of classical electromagnetic theory, for the retarded potentials due to an electron moving in any manner, are replaced by a tensor formula which gives the classical result in the absence of a gravitational field, and which is certainly valid in the "quasi-uniform" gravitational field [see Abstract 695 (1928)]. The formula obtained is as follows: Let an electron e be moving in any manner, and let τ be its proper time at the point where its world-line intersects the null-cone of any point ρ. Then the electromagnetic potential-vector at ρ due to the electron e is

$$\phi_p = \frac{e}{c}\sum_{q,\,r} g^{qr}\sigma_{pqr},$$

where

$$\sigma_p = \tau_p \Big/ \sum_{l,\,m} g^{lm}\tau_{lm}$$

and where the subscripts p, q, r, l, m, on the right-hand side represent covariant differentiations. Although it is not certain that this formula is valid in the most general gravitational field, it is conjectured that the expression for the potential must be some combination of covariant derivatives of σ_p although perhaps another than that given here.

W. S. S.

3068. Free Electron in a Homogeneous Magnetic Field according to Dirac's Theory. I. I. Rabi. *Zeits. f. Phys.* 49. 7–8. *pp.* 507–511, 1928.

Dirac's four wave equations for the four wave functions are written down for this case and the eigen values and eigen functions determined. The results obtained correspond to a splitting of the eigen values of the non-magnetic electron owing to the alignment of the electron parallel or antiparallel to the field. W. S. S.

3069. Electrification of Dielectrics. K. Nakata. *Phys. Math. Soc. Japan, Proc.* 9. *pp.* 179–190, *Dec.*, 1927. *In English.*

An account is given of the continuation of investigations previously described [see Abstract 698 (1928)]. Carnaüba wax shows positive electrification when a metal plate, such as copper or aluminium, is peeled off from its surface, the two being initially in close contact. Experiments have now been made with the object of finding if the charges on an "electret" are of the nature of contact electricity. Plates of aluminium and tinfoil were used, and the results of the experiments indicate some connection with the phenomena observed and contact electricity. Various mixtures of carnaüba wax and resin constituting electrets were examined to find whether their structure accounted for the charges of electricity developed, but further investigation is required. The microscopic structure of electrets was examined and some regular orientation of microcrystalline structure in the direction of the electric field which was applied during its preparation was found, but it is still doubtful if this regular structure is connected with the electrification of the electret.

J. J. S.

3070. Influence of the Extension and State of Contraction of the Surface in the Frictional Electrification of Mercury. V. Polara. *N. Cimento*, 5. *pp.* 127–136, *April*, 1928.

The following observations were made in experiments on the frictional electricity developed on the contact of mercury with glass: (1) On the diminution of the extension of a surface of mercury excitable positively on contact with glass, such positive excitability first decreased and then became negative when the diminution of the free surface increased beyond a given limit. (2) The rapidity of ageing towards air of a fresh surface of mercury is notably influenced by its extension, the passage from the positive excitability to the negative excitability coming on more rapidly for a surface less extended. (3) The rapidity of ageing towards air is influenced by the state of contraction of the free surface of the mercury—that is, by its radius of curvature—the passage from the positive excitability to the negative coming on more rapidly for a surface of less radius of curvature. The meaning of these results is considered, and of the influence of the radius of curvature on the rapidity of ageing an explanation is given with the aid of Frenkel's theory of the intrinsic potentials, which later researches may confirm or modify. J. J. S.

3071. Deformation of Current-Field. A. Rostagni. *N. Cimento*, 5. *pp.* 204–212, *June*, 1928.

A general expression is worked out for the distribution of current from two point-electrodes at *finite* distances apart in a plane conductor, indefinite and of uniform conductivity, in which there is a sphere of another conduc-

tivity. The lines of force to the surface are studied with the view of ascertaining from these the position and the diameter of the interposed sphere. Some cases of maximum perturbation are considered. A. D.

3072. Radioactive Down Discharges on High Antennæ. F. Schindelhauer. *Phys. Zeits.* 29. *pp.* 479–487, *July* 15, 1928.

Investigations were carried out at the Observatory in Potsdam. The vertical current flowing in with the normal earth field on a projecting point of the earth's surface was measured. This current is chiefly produced by radioactive attack on the electrodes. The earth and atmospheric conditions play a decisive rôle. The current strength increases with falling air pressure and with rising earth temperature. Material exchange in the lower layers has influence, as is seen from comparison with wind velocity, state of cloudiness and vertical temperature gradient in the lowest layers of the atmosphere. Both the aperiodic changes and the daily course of the collector current proceed in general parallel with the potential gradient. The morning maximum of the potential gradient in summer may be explained by the course of the collector current: there is caused through the setting in of the collector current an enrichment of positive carriers in the lower layers of the atmosphere. The daily course of the collector current may be explained by the daily variation of the interchange coefficient directly over the surface, by which the content of the air in radioactive gases is changed. The measurements yielded extraordinarily high values of the vertical current. J. J. S.

DISCHARGE AND OSCILLATIONS.

3073. Velocity of Particles Sputtered by Disruptive Discharge. H. Nagaoka and T. Futagami. *Imp. Acad. Tokyo, Proc.* 4. *pp.* 201–204, *May*, 1928. *In English.*

The spark takes place between glass plates, one of which is provided with a horizontal slit. The tracks of particles emerging are photographically recorded on a rapidly rotating drum. The tracks for Ce, W and Mg are described and illustrated. The speeds of W particles range from 71 m. per sec. to 5 m., for Mg from 54 m. to 0 m., and for Ce from 130 m. to 10 m. F. S.

3074. Electric Discharges in Gases. G. Valle. *N. Cimento*, 5. *pp.* 195–203, *June*, 1928.

The multiplicity of forms or phases presented by the passage of electricity in gases raises a problem as to the natural succession of these phases in transitory processes such as increase of current, extinction, spark, etc. A theoretical diagram is discussed which takes in the most recent theories and represents a first attempt to make a complete synthetic representation of the phases of an electric discharge and their succession in transitory processes, whether abrupt or continuously variable. A. D.

3075. Form and Structure of Sparks. Part IV. Influences of Electrode Form. T. Terada, U. Nakaya and R. Yamamoto. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers*, 8. *No.* 143. *pp.* 197–213, *June* 19, 1928. *In English.*

Describes the differences in form and structure of the sparks obtained

when the diameter of symmetrical spherical electrodes is varied. The variations in the lengths of the corresponding parts of the sparks, due to the changes in diameter and spark gap, are investigated, and a characteristic form of the spark, which takes the shape of a small knob at the end of the positive part of the spark, is described. Differences are also investigated in the structure of sparks obtained with sphere and disc electrodes when the polarities are reversed and the spark gap varied, whilst the effects of an air blast on the sparks obtained are tried at various parts of the sparks. Earthing either electrode results in a decrease in the field in front of the earthed electrode, with a consequent hindering of the formation of the brush discharge. The sparks in the case of the negative sphere and positive disc are divided into four types, according to the structure and luminosity of various parts of the spark. Such a number of types cannot be satisfactorily explained, although an attempt is made to explain the possible mechanism of a special type of discharge termed "three-part spark." Numerous photographs are appended clearly illustrating the types of sparks obtained under various conditions.

R. C. F.

3076. Smallest Carriers of Electricity in Gases. H. Schilling. *Ann. d. Physik*, 86. 3. *pp.* 447–448, *June* 30, 1928.

The criticisms of Loeb [see Abstract 1962 (1928)] on the author's data for the mobility of ions in air are repudiated. L. L. B.

3077. Temperature of the Under-Water Spark as Computed from the Distribution of Intensity in OH Absorption Bands. E. D. Wilson. *J.O.S.A. and R.S.I.* 17. *pp.* 37–46, *July*, 1928.

Detailed measurements of the OH-bands found absorbed in the under-water spark reveal that the system is developed in absorption almost as completely as in emission. Calculations based on intensity distribution lead to a value of approximately 5000° C. for the effective temperature of the source. AUTHOR.

3078. Relation between Current Density and Kathode Fall in the Glow Discharge, Using a Guard-Ring Kathode and Correcting for the Rise of Temperature of the Gas. A. Güntherschulze. *Zeits. f. Phys.* 49. 5–6. *pp.* 358–379, 1928. *From the Reichsanstalt.*

The kathode was a cylindrical plate of iron, which with its guard-ring weighed 2·3 kg., the heat capacity being so great that it was only very slightly warmed during a series of experiments. The mean rise of temperature of the gas was calculated, and the mean free path in the fall space was used as the experimental variable quantity. He, Ne, Ar, H_2, N_2 and O_2 were experimented with. Helium was the only gas which satisfied the equations $l\sqrt{j}=$const. and $d/l=$const., the kathode fall being constant (l = mean free path, j = current density, d = length of fall space). It is only in the case of helium that the relation between kathode fall, current density and mean free path can be represented by a single curve. The disturbances which take place in the discharge through the other gases could only be eliminated by using much smaller current densities, *i.e.*, smaller pressures than in the author's experiments. This would necessitate the use of kathodes measuring several square metres in vessels containing several cubic metres of gas. H. N. A.

3079. Relation between the Normal Kathode Fall of the Glow Discharge and the Gas Density. A. Güntherschulze. *Zeits. f. Phys.* 49. 7–8. *pp.* 473–479, 1928.

Uses the heavy iron guard-ring kathode previously described. In helium the normal kathode fall rose 3 % when the pressure was diminished from 4·3 mm. to 0·50 mm.; in argon the increase was 6·6 % when the pressure fell from 7·2 mm. to 0·31 mm.; with oxygen and air the change with pressure was very small indeed; hydrogen gave an increase from 250 volts at 15 mm. to 318 volts at 0·4 mm., and the relation between voltage and pressure was different for diminishing and for increasing pressure; this is also the case with nitrogen. In pure nitrogen the normal kathode fall rises from 162 volts at 23 mm. to 262 volts at 0·05 mm. Helium is the most suitable gas for experiments to determine the relation between the normal kathode fall and the material of the kathode, since in air or oxygen most metals would be covered by a film of oxide and the values for the metals would not be obtained. H. N. A.

3080. Diffusion of Kathode Rays. O. Holtzmann. *Ann. d. Physik*, 86. 2. *pp.* 214–240, *June* 15, 1928.

The diffusion of kathode-rays of 100-volts velocity in the gases nitrogen, hydrogen, helium, neon and argon is investigated. In all cases true reflection of kathode-ray electrons is observed, and preponderates over diffusion; so much so in the cases of hydrogen, helium, neon and argon, that strict quantitative estimation of the diffusion was difficult. On the axis of the kathode-ray beam a falling-off in velocity was found in all gases, of considerable magnitude (in argon steps of 20, 40, 80 volts, and in helium of 20 volts), while far out from the axis there were no such losses. This is taken to show that the true reflection takes place without loss of velocity, as has already been shown for reflection from solid surfaces. A. C. M.

3081. Liberation of Electrons from a Metal Surface by Positive Ions. F. M. Penning. *K. Akad. Amsterdam, Proc.* 31. 1. *pp.* 14–23, 1928.

3082. Quantum Theory of the Autoelectric Field Currents. J. R. Oppenheimer. *Nat. Acad. Sci., Proc.* 14. *pp.* 363–365, *May*, 1928.

It is pointed out that the author's quantum mechanics expression [see Abstract 1172 (1928)] for the rate at which ionisation jumps in hydrogenic atoms are brought about by an intense electric field F, leads immediately to the experimental formula of Millikan, Eyring and Lauritsen [see Abstract 1367 (1928)], for the autoelectric field current i, namely, $\log_e i - \frac{1}{4}\log_e F = C/F$. C in volts per cm. is related to the ionisation potential W in volts, by the formula $C = -10^8 W^{3/2}$. Values of W deduced from the empirical constant C come out, however, to a few tenths of a volt. This result is explained as being due to the emission occurring only at a few points where the field strength is abnormally high. Assuming a value for W, the number of atoms participating in the effect is computed as a proportion of the total number of surface atoms and shown to be of the same order as the result derived by microscopic examination of the surface. The theoretical treatments of the autoelectric effect given by Houston [see Abstract 1371 (1928)] and Richardson [see Abstract 1372 (1928)] are criticised adversely. W. S. S.

3083. Mobilities of Gaseous Ions in SO_2 and SO_2–H_2 Mixtures. L. du Sault and L. B. Loeb. *Nat. Acad. Sci., Proc.* 14. *pp.* 384–393, *May*, 1928.

Two sets of mobilities were observed at atmospheric pressure in SO_2. The absolute values for the supposed less pure sample were 0·34 cm./sec. and 0·32 cm./sec. for positive and negative ions respectively. For the other sample the values 0·48 and 0·44 were obtained. The mobilities observed directly at pressures from 10 mm. upwards, and reduced to 760 mm., appeared to decrease slightly with increase of pressure, an effect probably ascribable to the higher purity obtained at lower pressures. The observed negative mobility in these measurements is invariably less than the positive. The effect of SO_2 at higher concentrations in $SO_2 - H_2$ mixtures is similar to the effect of NH_3 in $NH_3 - H_2$ mixtures. At low concentrations the formation of a relatively simple and mobile positive ion must be assumed to account for the observed positive mobility of 22 cm./sec., the negative ion as in NH_3 being unaffected except to have its mobility slightly reduced. W. S. S.

3084. Mobility of Ions or Electrons in Gases. R. J. van de Graaff. *Phil. Mag.* 6. *pp.* 210–217, *July*, 1928.

Frequently in determining the velocity of ions or electrons in the direction of an electric force the quantity measured is an upper limit or a lower limit of the mean velocity. The author has devised a method of measurement the principle of which is the same as that used by Fizeau in determining the velocity of light where a rotating wheel is used to break up a beam of light into sections which travel a known distance and then again encounter the periodic shutter. In the apparatus for the determination of the velocity of ions an oscillating potential in combination with grids gives the shutter effect corresponding with that of the rotating toothed wheel of Fizeau. If the mobility W_0 be defined as the velocity of the ions under an electric force of 1 volt per cm. in the gas at 760 mm. pressure, the velocity at the pressure p is $W = 760W_0X/p$. The mean of the author's experiments gives $W_0 = 5·8$ cm. per sec. for positive ions in hydrogen. J. J. S.

3085. Positive Ion Bombardment of Solids. M. L. Oliphant. *Cambridge Phil. Soc., Proc.* 24. *pp.* 451–469, *July*, 1928.

A preliminary account of experiments made with the object of investigating the relation between the energy of a positive ion and the effect produced on a surface which it bombards. The steady source of positive ions capable of functioning in a high vacuum discovered by Kunsman was used [see Abstract 1119 (1927)]. This source supplies an exceedingly homogeneous beam of singly charged atoms. The experiments carried out seem to offer strong support to a photoelectric theory of the production of electrons by neutralisation of positive ions at the kathode, as suggested by J. J. Thomson. J. J. S.

3086. Energy Distribution in the Cross-Section of the Positive Column in Neon and Helium. G. Zwiebler. *Ann. d. Physik*, 86. 2. *pp.* 241–290, *June* 15, 1928.

The cross-section of the positive column was studied spectrophotometrically, using the method of Kurlbaum and Güntherschulze. The energy of the radiation falls off from the centre towards the edge, at first

quickly and then more slowly. The fractional radial decrease in the energy is greater, the greater the intensity of the spectral-line considered, in the middle. The fractional radial decrease in energy increases with the pressure, but seems to tend to an asymptotic limit. The fractional radial decrease in energy decreases with increase in current strength, especially at the edges. These conclusions are illustrated by many tables and graphs. A. C. M.

3087. Ionisation of Mercury Atoms by Helium Ions. J. Stark. *Ann. d. Physik*, 86. 4. *pp.* 541–546, *July* 10, 1928.

The process of ionisation of a gaseous atom is usually regarded as being due to the taking up of kinetic energy by an outer electron in the atom from a colliding particle or from an incident light-quantum. The author outlines a second possibility; an atom A and an ion B^+ which approach sufficiently near to one another can do one of three things: (1) An electron belonging to one or the other may change its equilibrium position, with subsequent separation of A and B^+ again; (2) an electron may take up a position of binding, so as to form $(A - B)^+$; or (3) an electron may move across with the subsequent formation of A^+ and B. The conditions for this last process are: (*a*) The ionisation potential of the outer electrons in B must be greater than that of the electrons in A, and (*b*) the tendency for the two atoms to associate (process (2) above) must be small. This ionisation process is studied in helium-mercury mixtures, where the conditions above required are readily fulfilled. Kathode rays are caused to fall upon a mixture of helium and mercury vapour in the ratio of 1000 : 1. Thus a large number of He^+ ions are produced, for subsequent reaction with Hg atoms. If process (3) above occurs, there will be an intensification of the mercury spark spectrum in the negative glow. Thus by comparing the intensities of λ2848 (Hg^+) with 2894 (Hg) in mercury vapour alone, in helium + 0·001 Hg, and in neon + 0·001 Hg, the ionisation of Hg by He^+ can be followed. The intensity curves show clearly that this ionisation process takes place in the He-Hg mixture and to a far greater extent than in the Ne-Hg mixture. A. C. M.

3088. Photoelectric Current as a Function of the Field. A. Blanc. *Comptes Rendus*, 186. *pp.* 1835–1837, *June* 25, 1928.

In air at the ordinary pressure the curve representing the photoelectric current as a function of the field shows no saturation. This does not agree with the formula of J. J. Thomson, which supposes that the number of ions appearing per sec. and per unit of surface is constant and equal to the number of electrons emitted by the metal. This formula indicates the existence of saturation. The author has compared the forms of these curves for various metals: Al, Zn, Sn, Cu, Hg, Pb, Fe, Ag, Au, Pt. The strip of metal was illuminated by light which could be varied from a mercury arc in quartz. (1) For one and the same metal with different illuminations a family of curves was obtained of which the ordinates were for the same field proportional to the illuminations. Thus for two illuminations and for different values of the field the ratio of the intensities is constant. (2) For two different metals the two curves can be made to intersect, but they do not coincide. The two curves do not belong to the same family. Thus, other things being equal, the form of the curve depends on the nature of the metal. Saturation is obtained easily in a vacuum, then the number of the electrons emitted does not depend on

the field. But at pressures sufficiently high the electrons can ionise the gas. Besides, the number of ions produced on the average by each electron increases with the field and in a way which depends on the metal. In reality the electrons have a variable initial energy. J. J. S.

3089. Photoelectric Current as a Function of the Field. A. Blanc. *Comptes Rendus*, 187. *pp.* 171–173, *July* 17, 1928.

The form of the curve which represents the photoelectric current as a function of the field in air at ordinary pressure depends strictly on the redistribution of the velocities of the electrons emitted by the metal. It is convenient to make to correspond to each curve a number equal to the ratio of the two ordinates obtained for two determined values of the field, arbitrarily chosen, but the same for all the curves to be compared. For the same metal, when the illumination is varied, the ratio mentioned remains invariable. For different metals the ratio varies; the two fields being kept the same, to each metal there corresponds a determinate value of this ratio, which the author calls its *characteristic ratio*. The limiting frequency being the frequency below which the photoelectric effect is not produced, in general the characteristic ratio appears to be greater for the metals whose limiting frequency is smaller. The distribution of the velocities of the electrons depends on the frequency of the light if it is monochromatic and on its composition if it is not so. The same applies to the form of the curve of the photoelectric current. It was found from experiments on platinum that the characteristic ratio diminishes as the fatigue increases, at first quickly, then more slowly. Fatigue modifies the redistribution of the velocities of the electrons, contrary to the conclusions of Hallwachs. Fatigue seems to be accompanied by a progressive increase of the limiting frequency. J. J. S.

3090. Angular Scattering of Electrons in Hydrogen and Helium. G. P. Harnwell. *Nat. Acad. Sci., Proc.* 14. *pp.* 564–569, *July*, 1928.

An apparatus is described for measuring the variation of electron scattering with scatter angle, of helium and molecular or atomic hydrogen, the last named being produced by a discharge tube in direct communication with the scattering chamber. In no case were favoured angles for electron scattering from hydrogen or helium observed, and for helium the results obtained by Dymond [see Abstract 1859 (1927)] were not able to be reproduced. W. S. S.

3091. Reflection of Electrons. S. Szczeniewski. *Comptes Rendus*, 187. *pp.* 106–109, *July* 9, 1928.

Preliminary experiments on the reflection of kathode rays by a cleavage surface of a bismuth crystal under three values of the accelerating potential and for different angles of incidence; a method analogous to that of the rotating crystal. Theoretical previsions are confirmed. A. D.

3092. Propagation of Electric Waves in Cables with Two Insulating Layers. N. H. Frank. *Ann. d. Physik*, 86. 3. *pp.* 422–434, *June* 30, 1928.

The rate of propagation of electric waves in metallic-covered cables possessing two layers of insulation was calculated from Maxwell's theory according to the method used by Sommerfeld. An experimental proof of these relations was made by measuring the rate of propagation of electric disturbances along a wire with the help of Lichtenberg figures, and indi-

rectly the dielectric constants were found. The cables employed had a copper wire, a rubber covering whose thickness was varied in the series of tests, a concentric copper cylinder outside this, and then either air or ethyl alcohol around the cable. The experimental results confirm the theory within the limits of error due to variability in the rubber and possible loss of concentricity between the copper cylinder and the inner copper wire. [See also Abstract 1184 (1907).] R. S. R.

3093. Natural Period of Linear Conductors. C. R. Englund. *Bell System Techn. J.* 7. *pp.* 404–419, *July*, 1928.

This paper describes the experimental determination of the frequency of free electrical oscillations of straight rods and circular loops. The results agree more closely with the formula of Abraham than with that of MacDonald. For three rods whose lengths were 300 cm., 250 cm. and 227·1 cm., the ratio of wave-length at resonance to rod length had the values 2·11, 2·13 and 2·13 respectively. Measurements taken upon 250-cm. rods bent into circular arcs of different radii gave values of the ratio of resonant wave-length to arc-length which passed through a minimum value and were virtually independent of the radius of the arc over a wide range, deviating markedly only at the extreme value of minimum radius possible and infinite radius. The extreme measured range of the ratio was 2·05 to 2·166. The wave-lengths were measured upon a pair of Lecher wires, and a very satisfactory meter for the rapid comparison of waves of short length was found to be a quarter wave-length Lecher frame. This frame showed a constant end correction so that $\lambda = 4(d + 3\cdot1)$, d being the length of the parallel rods. AUTHOR.

3094. Production of Short Electric Waves by Means of a Triode Valve. O. Pfetscher. *Phys. Zeits.* 29. *pp.* 449–478, *July* 15, 1928.

A theoretical paper in which the various processes involved are treated in detail. First of all the potential distribution within the valve is examined, and then the influence of the external oscillatory circuit is considered. From the results it is concluded that there is a practical limit to the shortness of the waves that can be generated, due to the self-capacity of the valve and the finite velocity of the electrons. If V_a is the anode potential and V_g the grid potential, it is stated that the lowest wave-length that can be generated when $V_a >> V_g$ is 120 cm. and if $V_a << V_g$ it is of the order of 45 cm., and to obtain a shorter wave-length a special construction must be resorted to, which will give a much lower capacity than present practice permits. G. E. B.

3095. Analogy between the Crystal Detector and a Vacuum Tube. W. Ogawa. *Phil. Mag.* 6. *pp.* 175–178, *July*, 1928.

Experiments are described which were carried out in support of the author's theory that the rectification by a crystal detector is brought about by the difference of electrons emitted from each electrode. The conclusion reached is that a crystal detector is nothing else than a cold vacuum tube which works as a rectifier by the difference of electron emissions from two electrodes badly insulated. J. J. S.

3096. Detector Contacts. F. W. Kallmeyer. *Ann. d. Physik*, 86. 4. *pp.* 547–586, *July* 10, 1928.

The non-ohmic conduction of so-called detector contacts depends on

occurrences of a yet unknown nature in a very thin layer at the surface of separation of two conductors which form an imperfect contact. With alternating potential of 50 periods per sec., characteristic lines of a great number of detector contacts with alternating contact pressure were obtained. Lines with hysteresis loops were frequent. Many of these originate when with rising potential in one direction an increase of conductivity suddenly occurs which with decreasing tension remains the same but is again increased by oppositely directed potential. The changeability of the characteristic lines with constant external relations and the frequent appearance of negative contact resistance are peculiarities of detector contacts hitherto little considered. Investigations with a crystal contact in a vacuum glow tube led to the conclusion that no detector action in a contact is possible without adsorption layers. The characteristic lines of metal contacts could not be obtained with constant potential, but were well produced by low frequency alternating potential. The observations made render it probable that the detector contacts are imperfect contacts whose peculiarities are conditioned by the adsorption layers adhering to the conductors. The change from non-ohmic to normal conduction with increasing contact pressure is explained by the hypothesis that the separating adsorption layers in the contact surfaces are squeezed, thereby rendering possible direct touching of the same. J. J. S.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

3097. Sommerfeld's Electron Theory of Metals. E. H. Hall. *Nat. Acad. Sci., Proc.* 14. *pp.* 370–377, *May*, 1928.

The Sommerfeld theory is discussed in detail, each aspect dealt with by Sommerfeld [see Abstract 1368 (1928)] being subjected to criticism, mainly destructive. W. S. S.

3098. Electron "Free Path" and Supra-Conductivity in Metals. E. H. Hall. *Nat. Acad. Sci., Proc.* 14. *pp.* 377–380, *May*, 1928.

The notion of "free path" for electrons in a metal is made more definite by defining the termination of the free path as the capture of the electron by a positive ion. The consequences of this hypothesis are worked out with respect to the specific heat, dependence of conductivity on temperature, and supra-conductivity, of metals. W. S. S.

3099. Conductors and Half-Conductors. H. Toby. *Ann. d. Physik*, 86. 3. *pp.* 353–392, *June* 30, 1928.

In researches on the phenomenon of electric adhesion and the system of half-conductors and conductors with the so-called Johnsen-Rahbek effect, it has always been difficult to reproduce exactly the results of the experiments. There is a connection between the degree of moisture which is present and the phenomena of the J. R. system, and the undefined degree of dampness has a disturbing influence on the results. This has led the author to repeat the experiments and arrange the J. R. system in an evacuated glass tube so that the moisture can act in a natural way in the form of water vapour and its influence be definitely determined. In this paper an account is given of the results of these observations. The electric adhesion was determined by a method in which the separation of the electrodes was produced by the attractive power of an electromagnet. The adhesion follows the Thomson formula, which is

$F = c \cdot \epsilon \cdot S \cdot V^2/8\pi r^2$, where F is the force of adhesion, c a constant, ϵ the dielectric coefficient, S the surface, V the tension, and r the distance of the plate from the material (rock, slate, etc.). Thus the adhesion increases with the square of the potential. It is, within wide limits, independent of the current traversing the system and is chiefly dependent on electrostatic factors. With increasing moisture the surface structure of the partial conductor changes at smaller electrode distances, so the adhesion is increased, but it changes sign and with the highest degree of moisture it disappears. The strength of the current traversing the system is, to a first approximation, a function of the mechanical pressure exerted on the contact surfaces, so also is it of the adhesion which predominates over the attractive forces on the plate. J. J. S.

3100. Theory of Metallic Conductivity Treated by Wave Mechanics. J. Frenkel and N. Mirolubow. *Zeits. f. Phys.* 49. 11–12. *pp.* 885–893, 1928.

Frenkel has derived a simple formula for the electrical conductivity of metals, using the theory of wave mechanics; the formula holds for the limiting case of high temperatures [see Abstract 1972 (1928)]. Houston has attacked the same problem, using a more complicated method, but did not obtain more accurate results. The authors now give an account of a fuller treatment, which they had previously applied, in which the distribution of the velocity is taken into account, and the variations of density responsible for the scattering of the electrons determined by means of Brillouin's theory of the scattering of light in solid bodies. A table gives the values of ρ, the relative specific resistance of gold and of platinum at different temperatures, that at $T = 273°$ abs. being taken as unity, as calculated roughly by means of the theory, and the values as observed for temperatures ranging from 20° abs. to 773° abs., together with Houston's values. H. N. A.

3101. Suggested Theory of Electric Conduction. W. H. McCrea. *Cambridge Phil. Soc., Proc.* 24. *pp.* 438–444, *July*, 1928.

The wave mechanical problem of a single electron in the field of two nuclei and a uniform external field is treated by regarding the existence of two nuclei as a perturbation of the hydrogen atom problem, and then the external field as a perturbation of the perturbed system so obtained. It is found that if it is equally probable that the electron is attached initially to either of the nuclei, then in a larger number of similar systems there will be, after a finite time, a net movement of negative charge against the potential gradient of the external field. This idea is developed into a theory of electric conduction. W. S. S.

3102. Conductivity of Powdered Salts. J. Cichochi. *Comptes Rendus*, 187. *pp.* 287–289, *July* 30, 1928.

The conductivity of crystals is much smaller than that of the powdered salt. The conductivity of the powder is due, not only to the conducting power of the particles, but also to the conductivity of the vapour of the salt. In order to test this theory, experiments were made with barium chloride which was carefully dried and placed in a copper tube. A copper wire was passed through the tube and was used to heat the salt. The whole apparatus was contained in a glass vessel which was evacuated. The temperature of the exterior of the tube, the intensity of the current, the fall of potential in the wire, the time of passing of the anode current,

were measured. It was found that the results indicate the presence of conducting vapour of barium chloride, but the conductivity of the salt was due partially to the penetration of copper into the salt. F. J. B.

3103. Volta Effect. E. Dubois. *Comptes Rendus*, 186. *pp.* 1832–1833, *June* 25, 1928.

Further measurements were made with a new form of apparatus to find the effect of water vapour on the Volta effect. Both electrodes were made of the metal tested, but one was heated and the other was cold. It was found that in water vapour Ni, Mo, Al and Cu, especially, become more electropositive, and in a few seconds a Volta effect of several tenths of a volt may be reached. For Ag, Au and Pt no effect was measured. [See Abstract 3198 (1927).] R. S. R.

3104. Current Conduction in Solid Insulators. R. Seeliger. *Phys. Zeits.* 29. *pp.* 489–492, *July* 15, 1928.

A theoretical discussion of the explanations which have been given of conduction in solid insulators and of the supposed counter e.m.f. or polarisation effect which may occur. The author considers it is not correct to conclude: That Ohm's law holds, and holds continuously, and the deviations are only apparent and are to be explained by the production of a counter e.m.f. But a much more correct statement is the following: That Ohm's law does not hold, from the beginning it does not apply, the deviations are not merely apparent, but the nature of the processes occurring are quite different from those in currents following Ohm's law.

J. J. S.

3105. Dielectric Constants of Aqueous Solutions of Amino Acids. G. Hedestrand. *Zeits. f. phys. Chem.* 135. 1–2. *pp.* 36–48, *June*, 1928.

Details are given of the method employed for measuring the dielectric constants of aqueous solutions of glycocoll, α- and β-alanine, taurine, aminobenzoic acid and benzidine. The apparatus used was a modified Nernst capacity bridge, the analyser being a crystal detector and telephone. Glycocoll, α- and β-alanine, and taurine cause a rise in the dielectric constant of water, the increase being proportional to the concentration. The values for glycocoll do not agree with those found by Fürth except at low concentrations. The fact that the aminobenzoic acids depress the dielectric constant of water may be ascribed to the reducing effect of the ions. The effect with benzidine is extremely small. An examination of the action of sodium chloride showed that it produces an equal lowering of the dielectric constant of water and of glycocoll solutions. The effect is thus due to the action of the electrolyte ions on the water. L. L. B.

3106. Dielectric Constants. H. Hellmann and H. Zahn. *Ann. d. Physik*, 86. 5. *pp.* 687–716, *July* 28, 1928.

A polemical experimental paper upholding and extending earlier work [see Abstract 783 (1927)]. A. D.

3107. New D.C. Potentiometer. M. Sase. *Phys. Math. Soc., Japan, Proc.* 9. *pp.* 163–168, *Nov.*, 1927. *In English.*

Describes a simple modification of the shunt dial type designed with a view to reducing the effect of contact resistances. E. G.

3108. New Construction of the Perucca Electrometer. E. Perucca and C. Leiss. *Zeits. f. Phys.* 49. 7–8. *pp.* 604–606, 1928.

The instrument described is really a considerably improved type of Hankel electrometer. The suspension and needle are of gilded quartz fibre and the plates are also gilded. With the small moment of inertia great sensitivity is obtained, there being a movement of one division in the micrometer eyepiece per 0·001 volt. Air damping is used and the movement is aperiodic. The apparatus is exceptionally rigid and stable and easily transported, and, being wholly enclosed, thermal convection disturbances are avoided. R. S. R.

3109. Non-Inductive Coils and Resistance Boxes. D. C. Gall. *Journ. Sci. Instruments*, 5. *pp.* 222–225, *July*, 1928.

The author explains the windings employed in various coils to reduce inductance and capacity and so get a resistance independent of frequency. Sealing hermetically preserves the coil from changes due to alterations in humidity. When building up the successive coils for a box precautions are employed by adjusting successive coils to reduce the effective inductance. R. S. R.

3110. Measurement of High D.C. Potential Differences with Applications to the Calibration of Electroscopes and Electrostatic Voltmeters. W. Bender. *J.O.S.A. and R.S.I.* 17. *pp.* 72–76, *July*, 1928.

An arrangement is discussed of condensers, switches and a ballistic galvanometer, by means of which high d.c. potential differences can be measured with considerably greater precision than by ordinary h.v. electrostatic voltmeters. Simple equations of design are derived, which, if scrupulously followed, will give 0·5 % (and greater) accuracy no matter how high the d.c. potential difference is. The application of this method to the calibration of an electroscope is given in detail. AUTHOR.

3111. Measurement of Capacity and High Resistance by Means of a Thermionic Valve. G. R. Toshniwal. *Journ. Sci. Instruments*, 5. *pp.* 219–221, *July*, 1928.

Charging a capacity by means of a suitable battery and discharging it through the grid-filament circuit, provided with a suitable grid leak, it has been found possible to determine the value of a very small capacity by noting the change in the anode current. By a similar process values of high resistances have also been obtained. AUTHOR.

3112. Measurement of Capacitance in Terms of Resistance and Frequency. J. G. Ferguson and B. W. Bartlett. *Bell System Techn. J.* 7. *pp.* 420–437, *July*, 1928.

The adaptation of a bridge circuit due to M. Wien, together with apparatus and procedure, is described which permits the measurement of capacitance in terms of resistance and frequency with an accuracy comparable to that of the primary standards. Among its advantages over the Maxwell method commonly employed are the use of a single frequency voltage and the fact that there is no general limitation placed on the type of condenser which may be measured or on the frequency at which the measurement may be made. The method is also applicable to the determination of inductance since its unit, like that of capacitance, may be derived from the units of resistance and frequency. AUTHORS.

ALTERNATING CURRENTS AND MAGNETISM.

3113. Theory of Wave Filters containing a Finite Number of Sections. H. A. Wheeler and F. D. Murnaghan. *Phil. Mag.* 6. *pp.* 146–174, *July*, 1928.

Response formulæ are developed for finite Campbell filters, so that reflections are taken account of without having to make a special adjustment of the end conditions, automatically taking account of reflections. Particular attention is given to the non-dissipative constant-K type filter, terminated by any values of resistance. Zobel's M-derived type is also treated, and its advantages over the former type are shown. These response formulæ are useful as showing the deviations from the ideal performance and from the approximate solution based on the infinite line. The solution for the latter ideal case is then obtained as a limiting case of the solution for the actual finite line, and the expressions for the iterative impedance and propagation exponent are derived. The authors apply their method to the problem of the natural frequencies of finite conservative lines of recurrent structure and obtain a convenient graphical solution which is applicable to lines of any recurrent structure, however complex. These frequencies are of theoretical interest, and bear a close relationship to the filter properties of the same lines. Two variations from the recurrent line are described. The first called an exponential line is built up of sections whose impedances change in geometric progression from section to section. The second is an alternating line with two recurrent sections in alternating succession. J. J. S.

3114. Design of Coils for the Production of Strong Magnetic Fields. J. D. Cockcroft. *Roy. Soc., Phil. Trans.* 227. *pp.* 317–343, *May* 31, 1928.

By Kapitza's method magnetic fields of the order of half a million to a million gauss can be produced. An enormous amount of power is passed into a solenoidal coil for a fraction of a second, the current being switched off from the coil before it has time to heat up seriously. As powers of 40,000 kilo-watts are available for dissipation in the coil magnetic fields of the order of 500,000 gauss are attainable. There is great difficulty in constructing a satisfactory coil, as pressures of 7000 kg./sq. cm. are attained in the body of the coil, forces which are far beyond the elastic limit of ordinary copper. These difficulties and the methods of overcoming them are discussed in this paper. A careful study is made of the exact magnitude of the forces and the resulting pressure distribution in the coil, and hence is determined the type of coil which will have the maximum strength. A second problem considered is the design of the coil so as not to exceed the safe temperature of the insulation used, and to produce the strongest magnetic field with the power available. Figures are given of the charts which are calculated and used for the design of coils, and of those which are applied to the calculation of the forces on coils. J. J. S.

3115. Magnetic Field of a Rectilinear Circuit and the Attraction of a Straight Wire. J. A. Tomkins. *Phil. Mag.* 6. *pp.* 205–209, *July*, 1928.

It is shown that the relation between the apparently diverse problems of the magnetic field of a rectangular coil and the gravitational attraction of a straight wire is such that a simple geometrical construction for the one is with a slight extension applicable to the other. J. J. S.

3116. Magnetic Energy of Permanent Magnets and of Linear Currents. H. V. Lowry. *Phil. Mag.* 6. *pp.* 192–194, *July*, 1928.

Starting from Maxwell's equations in the expression for the rate of increase of the electrical energy of the field the energy is in two parts, the first of which definitely depends on the magnetic properties of the field. If the field contains permanent magnets and no currents this part becomes $W = -\frac{1}{2}\int(I_0 H)dv$. If the field contains no permanent magnets and the currents are steady and flow in circuits, $\frac{1}{2}\int\mu H^2 dv$ transforms to $\frac{1}{2}\Sigma iN = (T)$, N being the total induction through a circuit carrying a current i.

J. J. S.

3117. Investigations on Bismuth by the Magnetic Molecular Ray Method. A. Leu. *Zeits. f. Phys.* 49. 7–8. *pp.* 498–506, 1928.

The deviation of rays of molecular bismuth in an inhomogeneous field as shown by Gerlach [see Abstract 1494 (1925)] is examined. The heating was done by bombardment with tungsten electrons, and the Bi rays were received on a nickel surface. These formed two broad deviated lines separated by a narrow undeviated line which disappears at higher temperatures. The asymmetry noted by Gerlach was not observed. Comparison of experiment with theory is made, and a rough calculation of the heat of dissociation gives the value 60,000 ($\pm$ 15,000) cal.

G. E. A.

3118. Magnetisation of Single Crystals of Nickel. S. Kaya. *Tohoku Univ., Sci. Reports*, 17. *pp.* 639–663, *June*, 1928. *In English. Report No.* 185 *of the Research Inst. for Iron, Steel and other Metals.*

Large crystals of nickel were prepared by slow solidification of the molten metal from below, and from these, three oblate spheroids were made with their equatorial planes coinciding respectively with the three principal planes. The magnetic properties were studied by the same method as for iron crystals [see Abstract 1888 (1927)], I-H curves being obtained for the directions of the principal axes. The crystals are magnetically isotropic for intensities up to 205; beyond this the magnetisation varies with the direction, being greatest along the trigonal axis, the next in order being the digonal and tetragonal axes, the reverse of the order in the iron crystal. With constant field, the parallel and perpendicular components of magnetisation in the three principal planes vary periodically according to the form of the space lattice in these planes. From the difference between iron and nickel in this respect, a phase difference of 45° in the periodic variation in the (100) plane was to be expected. The amplitude of these periodic variations is in decreasing magnitude in the principal planes (110), (100) and (111). G. E. A.

3119. Paramagnetism of Iron in Ferricyanide of Potassium. Paule Collett and F. Birch. *Comptes Rendus*, 187. *pp.* 35–36, *July* 2, 1928.

Employing the method of the non-uniform field, the authors found, for the Curie point of ferricyanide of potassium, $\theta = -13$ K, and for the atomic moment of iron, $n = 12$ magnetons for the temperature-range 0° to 200°. Honda and Ishiwara found, for the solid ferricyanide, $\theta = -49$K, and $n = 13$ between $-180°$ and 25°. It thus appears probable that the magnetic moment of the iron atom has various values in this compound. [See Abstracts 378 (1916) and 1584 (1924).] G. E. A.

3120. Earth Current Observations at Watheroo Magnetic Observatory, 1924–1927. O. H. Gish and W. J. Rooney. *Terr. Mag.* 33. *pp.* 79–90, *June*, 1928.

The apparatus used [see Abstract 784 (1924)] has been found helpful in detecting and locating the source of disturbing effects. The salient features of four years of measurements are summarised. The diurnal variation curve of the northward component has a mean range of 1·14 millivolts/km. with two maxima and two minima. The records resemble those obtained at Berlin and Ebro except that the curve is inverted and the amplitude is smaller. The reversal in the direction of current flow points to a symmetrical distribution of earth currents with reference to the equator. The smaller amplitudes are probably due to the unusually high conductivity of the region near Watheroo. No regular change in the mean diurnal variation for individual years was observed. There is a seasonal change in the diurnal variation from 0·71 millivolt/km. in June to 2·06 millivolts/km. in October and the morning minimum and midday maximum shift forward with increasing height of the sun. The amplitudes of the three principal harmonics vary with the season in a similar manner, indicating a single predominating cause for seasonal variation in the normal activity. The eastward component is extremely small at Watheroo; its diurnal variation curve has in general a double period and a mean range of below 0·15 millivolt/km. R. S. R.

3121. Line Integrals of the Diurnal Magnetic Variations. A. T. Price and S. Chapman. *Roy. Soc., Proc.* 119. *pp.* 182–196, *June* 1, 1928.

The line integrals of diurnal magnetic variations were obtained for a curve embracing Greenwich, Eskdalemuir, Rude Shov, Seddin, and de Bilt, while later, data for Stonyhurst were included. The data used were average hourly values of ΔH and ΔD or ΔN and ΔW for the 20 international quiet days of the period May–August, 1924, a year of low sunspot number. The results are tabulated. The errors due to the data used and interpolations made are discussed. The uncertainty in the calculated earth-air current densities is comparable with their magnitudes as thus estimated and the available magnetic data are inadequate to determine the real current densities. On the other hand, at most only a very small fraction of the diurnal magnetic variations can be supposed not to possess a potential. Further calculations based on more accurate data are required, but this will be difficult and costly unless new and simpler recording devices become available. R. S. R.

3122. Time Interval between Magnetic Disturbance and Associated Sunspot Changes. J. M. Stagg. *Meteorolog. Office, Geophys. Mem.* 5. *No.* 42. [16 *pp.*], 1928.

The results obtained by Chree for the years 1901–10 indicated a lag of four days between days of sunspot appearance and subsequent magnetic disturbance, a result in agreement with the time calculated by S. Chapman for particles expelled from the sun to reach the earth with a velocity of 10^6 cm./sec. The author extended the investigation to the period 1890–1924, using magnetic observations for Kew, and dealing with variabilities in the sunspot area. He found a well-marked tendency for the increase of sunspot area from the fifth to the fourth day prior to magnetic disturbance. The effect is more pronounced in years of high than in years of low sunspot frequency and varies considerably in individual years, while the effect

shows more for positive than for negative variability. The results for positive variabilities indicate that the day of greatest increase of sunspot area tends to advance from the fourth to the fifth day prior to the selected disturbed day, in passing from years of high to years of low sunspot development. It is considered that another factor, such as ionisation of the conducting layers in the upper atmosphere, produces a variable lag between the appearance of active sunspots and the subsequent magnetic storm. R. S. R.

3123. Correlation of Solar and Terrestrial Magnetic Phenomena. S. Chapman. *Nature*, 121. *pp.* 989–991, *June* 23, 1928.

At all observatories a character figure (D) is given to each day to represent its degree of magnetic disturbance; but there are daily variations which go on independently of whether disturbance is present or not. These two sets of changes show variations in rough parallelism with the sunspot cycle, but they differ in many ways. The writer has in various papers suggested reasons for believing that these two types of variation are associated with different types of solar emission. The present communication is really a preliminary announcement of investigations which are to be carried out on the steady daily variations on purely quiet days at Eskdalemuir and Greenwich. Subsequently it is hoped to correlate these data with solar observations. A. A. D.

3124. Null Method for Determining Magnetic Field Intensity. C. T. Lane. *Journ. Sci. Instruments*, 5. *pp.* 214–216, *July*, 1928.

A null method is described for the accurate measurements of a magnetic field in terms of the field inside a standard solenoid coil. It is claimed for the method that (1) since direct galvanometer readings are eliminated, experimental error is reduced; (2) the resistance in the galvanometer circuit may be varied within wide limits; (3) errors due to changes in the galvanometer constant or resistance of the galvanometer circuit in the interval between calibrating and making direct observations (in older methods) are avoided, and also errors due to changes in the galvanometer zero; and (4) where many observations are made the labour is much lessened. R. S. R.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

3125. Chronaxy by Means of Kathode Tubes. P. Fabre. *Comptes Rendus*, 186. *pp.* 1862–1863, *June* 25, 1928.

The application of the Braun kathode tube for electrophysiological measurements is described. The danger is the high voltage necessary, which restricts its use to animal experiments, but, with a tube having a supplementary Lilienfeld anode, lower voltages should be possible. B. J. L.

3126. Electrocardiography by Means of Industrial Oscillographs. P. Fabre. *Comptes Rendus*, 187. *pp.* 257–258, *July* 23, 1928.

The author has applied various commercial oscillographs to the purposes of electrophysiology. The difficulties are due to oscillation between valve tubes and the effects of external fields. Single-stage amplifications of 260 and two stage amplifications of 60,000 have been obtained, and the action of surface skin currents are avoided by the use of capacity coupling. The advantages are the comparative cheapness of commercial oscillographs, their robustness and their accuracy for rapid oscillations. B. J. L.

3127. Production of Electricity by the Torpedo Fish. E. Huguenard and A. Magnan. *Comptes Rendus*, 186. *pp.* 1863–1865, *June* 25, 1928.

The production of electric potential by the torpedo fish is discussed. If the fish is compressed between tin sheets, a voltmeter reading is first given, which then falls, and then again suddenly increases above the first value. The discharge varies according as to whether the fish's electric organ is compressed or not, and can also be obtained at a reduced value by compression of the electric organ of a recently dead fish. The authors advance the view that the electrical action occurs in two stages, the first action being non-voluntary, when the fish is first touched and compression of tissue occurs, followed after an interval of one-tenth second by a second discharge which is voluntary on the part of the fish. D'Arsonval has given an explanation of the action on the basis of electrocapillary action, and the present authors have been able to attribute the phenomena to filtration, or osmosis of solutions, *via* membranes. They consider the discharges are the sum of a number of successive discharges, separated by a time interval, and the velocity of conduction of discharge can so be made to vary. A mechanical analogy of this view is given. B. J. L.

3128. Tungsten-Filament Lamps in Radiation Therapy. M. Luckiesh. *Frank. Inst., J.* 206. *pp.* 57–64, *July*, 1928.

Some sources of ultra-violet light used in therapy are considered from the point of view of their output, and it is decided that the tungsten-filament lamp, when provided with suitable windows or special bulbs, might be a source of considerable value since, in spite of the small intensity in the ultra-violet, the times of exposure could be very great. At the moment, from lack of precise knowledge, the possibility at any rate cannot be excluded. Calculations show that, assuming the solar radiation to contain 2 % of ultra-violet radiation, a 500-watt lamp designed for 1000 hrs. life has 0·018 %. Thence if we consider the physiological effect as simply proportional to the product of time of exposure and quantity of ultra-violet radiation, and taking normal values of illuminations in sun- and lamp-light respectively, it would require 83 hrs. exposure by the ordinary tungsten filament to be equivalent to 1 min. exposure to noon sunlight. The physiological assumption may not, however, be correct. The paper concludes with a discussion of the penetration of heat radiations in tissues. W. V. M.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

3129. Adsorption from Solutions of Mixed Electrolytes. M. Dubinin. *Zeits. f. phys. Chem.* 135. 1–2. *pp.* 24–35, *June*, 1928.

A study has been made of the simultaneous adsorption by activated wood or sugar charcoal of the following mixtures: hydrochloric and oxalic acids, nitric and oxalic acids, hydrobromic and nitric acids, hydrochloric and nitric acids, hydrochloric acid and acetone, acetic acid and acetone, sodium chloride and sodium, potassium, or barium nitrate, barium chloride and sodium or barium nitrate. The charcoal was purified by extraction with $4N$ HNO_3, followed by washing with water and heating *in vacuo* to 850°. Tests with a number of acids showed that the two ions were adsorbed in equivalent amounts, proving the absence of free ash-constituents. Bases were not adsorbed. For all the mixtures investigated, a linear relation was established between the adsorbed quantities of the two constituents, and the ratio $(b - y)/x$ was found to be constant, where b and x are the quantities of each constituent adsorbed in absence of the other, and y is the quantity of the first constituent adsorbed in presence of the second. L. L. B.

3130. Osmotic Pressures of Concentrated Solutions. J. H. Hildebrand. *J. Phys. Chem.* 32. *pp.* 1086–1088, *July*, 1928.

The author criticises the arguments of Bancroft and Davis, who have published two papers on the same subject. The modification of the Raoult law for osmotic pressure is objected to on the grounds that the alteration does not improve the result for describing actual systems. The limitations of the van't Hoff equation, $PV = RT$, for concentrated solutions and the van't Hoff constant i are discussed, and it is pointed out that better methods are now available for treating the problem of concentrated solutions than by utilising the van't Hoff equation. F. J. B.

3131. Critical Points and Martensitic Tempering of Castings containing Nickel and Nickel-Chrome. L. Guillet, Galibourg and Ballay. *Comptes Rendus*, 137. *pp.* 14–16, *July* 2, 1928.

Tempering is distinguished as primary or secondary. Secondary or martensitic tempering takes place when the metal is heated above the transformation point and then cooled suddenly. The experiments relate to a series of twenty castings containing 3·2 % to 3·4 % carbon, 0·9 % phosphorus, and variable quantities of Si, Mn, Ni and Cr. The specimens were all prepared in the same way, but two speeds of cooling were employed: (i) cooling in the furnace from 950° to 450° at 8° to 10° per minute; (ii) cooling by air currents through the same range at 250° per minute. Among the results found, silicon and nickel have opposite effects, and nickel lowers the transformation point and the critical speed of tempering. Chromium added to a casting containing nickel reduces the critical speed of tempering, and has, as in steels, a strong effect on secondary tempering. It may be possible to use these metals in producing two different categories of very resistant metals. G. E. A.

3132. Alloys of Lead and Antimony. W. Broniewski and L. Sliwowski. *Rev. de Mét.* 25. *pp.* 397–404, *July*, 1928.

Having studied the tin-antimony alloys [see Abstract 2855 (1928)]

the authors examine particularly the electric properties of Pb-Sb alloys, finding in their review of the literature that the previous determinations of the electric properties were concordant, but not in agreement with other properties. About 20 alloys of all proportions were examined as prepared and after annealing at 200° for 48 hours. An equilibrium diagram is given. The curves of resistance, electromotive force of solution (in acetic acid), thermoelectric power, hardness and dilatation do not indicate any definite compounds. There is no sign of the existence of Pb Sb, and the general appearance suggests solid solutions of either metal in the other and of mixtures of the solid solutions. Certain peculiarities in the resistance and dilatation curves are ascribed to changes in the orientation of the antimony crystals and to the solidification of the alloy round the sheath of the thermocouple. H. B.

3133. Studies in Homogeneous Gas Reactions. Part II. Introduction of Quantum Theory. L. S. Kassel. *J. Phys. Chem.* 32. *pp.* 1065–1079, *July*, 1928.

The theory of unimolecular reactions was given in a previous paper [see Abstract 1413 (1928)], in which it was assumed that activation is by collision, that the molecules have many degrees of internal freedom, and that the reaction occurs when some special degree of freedom acquires at least a critical amount of energy. The theory has been extended by the introduction of quantised degrees of freedom. The cases of quantum oscillators of a single frequency, and of two frequencies whose quotient is an integer, have been worked out, and the methods for the more complex cases have been indicated. The decomposition of nitrogen peroxide has been discussed, and the rate at which the reaction occurs at moderately high pressures is explained. The theory has been applied to azomethane, and it was found that the results may be completely accounted for by assuming oscillators in such numbers and of such frequencies as to give reasonable values to the molecular heat and the internal energy. When this is done, the value which must be assigned to the diameter for collisional deactivation is of the order of magnitude of kinetic theory diameters.

F. J. B.

3134. Relationship between the Temperature of Explosion of a Powder and the Velocity of Combustion. H. Muraour. *Comptes Rendus*, 187. *pp.* 289–290, *July* 30, 1928.

The temperature of explosion of mixtures of cotton powder with nitroglycerine was varied within wide limits by the addition of symmetrical diethyl-diphenylurea. A simple relationship was found to exist between the temperature and the velocity of combustion of the powder. The velocity of combustion of a colloidal powder mixed with nitroglycerine in equal proportions, and with varying quantities of the urea derivative was found to obey the law: the logarithm of the velocity of combustion is a linear function of the temperature of explosion. F. J. B.

3135. Decomposition of the Lead Atom. A. Smits and W. A. Frederikse. *Zeits f. Elektrochem.* 34. *pp.* 350–360, *July*, 1928.

Previous work on the lead-quartz lamp [see Abstract 1206 (1927)] which had given definite indications of the transmutation of lead is now extended. With the object of finding alternative data, experiments have been made with sparks in gases and liquid dielectrics at high voltages,

flame arcs in dielectrics at low voltages, rotating pyrex glass interrupters, and radiation. The results of the spark and arc experiments were negative, but those involving radiation seemed worthy of being continued. Since definite positive results could only be obtained with the quartz-lead lamp, the authors reserve their conclusions until confirmatory data have been assembled by other methods. H. H. Ho.

3136. Separation of Krypton and Xenon from Atmospheric Air. A. Lepape. *Comptes Rendus*, 187. *pp.* 231–234, *July* 23, 1928.

The separation of krypton and xenon from atmospheric air by fractional distillation results in obtaining only a fraction of the total of these gases present in the air treated. This is due to the increase of the amount of krypton and xenon in the vapour phase, as the distillation proceeds. In order to reduce these losses, the vapour phase during the fractionation was subjected to the adsorbing power of cocoanut charcoal or silica gel, at the temperature of boiling liquid oxygen. The adsorbed gases were liberated by heat. After removing the oxygen, carbon dioxide, nitrogen and combustible gases, the rare gases were separated by fractionation on suitably cooled cocoanut charcoal. The results showed that a very high yield could be obtained by this method, and several litres of krypton and a litre of xenon were prepared by this method, and the possibilities of its industrial application are being considered. F. J. B.

3137. Electrometric Titration with a Braked Auxiliary Electrode. E. Müller. *Zeits. f. phys. Chem.* 135. *pp.* 102–106, *June*, 1928.

A method of electrometric titration has been devised in which a braked electrode is employed in addition to the normal electrode. When two exactly similar electrodes are placed in contact with the solution under examination, and one is separated by means of a diffusion retarder, then the potential of this electrode will lag behind the other during the titration. The difference between the two electrodes during the titration is at first small, then rises to a maximum, and again falls. When the readings are plotted a curve with a sharp maximum is obtained. A special electrode, in which the two electrodes are combined, is described. Numerical data of typical titrations of ferrous sulphate with potassium permanganate, and sodium chloride with silver nitrate, are given. F. J. B.

3138. New Apparatus for the Moving Boundary Method of Determining Transference Numbers. E. R. Smith. *Am. Chem. Soc., J.* 50. *pp.* 1904–1906, *July*, 1928.

A new method for determining transference numbers has been devised. A moving boundary cell in which the boundary may be returned to the starting point for a new measurement any number of times has been described. The method consists of a closed side to the cell, and the withdrawing of mercury from the closed side, so as to oppose the motion of the boundary. The measurements are independent of any tube calibration. The mercury withdrawn is weighed to obtain the volume through which the boundary has passed. F. J. B.

3139. "Acid-Alkalimeter." A Direct-Reading *p*H Meter. K. H. Goode. *J.Q.S.A. and R.S.I.* 17. *pp.* 59–71, *July*, 1928.

An improved form of the direct reading pH meter previously described by the author [see Abstract 1797 (1922)] has been devised, in which oxide-

coated vacuum tubes are used in place of those of the thoriated filament type. Two modifications of the instrument are given, one of which operates directly from the 110 a.c. lighting circuit and the other from batteries. F. J. W.

3140. Influence of Electrolytes on the Cataphoretic Velocity and the Relationships between the Electrokinetic Potential and the Electromotive Potential of Gold. N. Thon. *Comptes Rendus*, 187. *pp.* 119–122, *July* 9, 1928.

A short note wherein is discussed the experimental results obtained by the measurement of the variations in the cataphoretic velocity by the aid of an ultramicroscope, these variations being produced by the addition of such salts as $ZnSO_4$, $NiSO_4$, $CuSO_4$, $Ca(NO_3)_2$, $Pb(NO_3)_2$. The research makes evident the separate and antagonistic actions of the anion and kation. J. K.

3141. Electrolytic Preparation of Cuprous Oxide. E. Abel and O. Redlich. *Zeits f. Elektrochem.* 34. *pp.* 323–326, *June*, 1928.

The conditions for the electrolytic preparation of cuprous oxide were experimentally investigated. It was found that the best electrolyte was found to be a slightly alkaline solution of sodium chloride, containing 110 grammes NaCl and 1·2 grammes NaOH per litre. The electrodes were so arranged that the oxide could not remain in contact with them. The current density employed was 0·5 to 1·0 ampere per square decimetre. The current was commutated periodically for 45 minutes in order to prevent the formation of spongy copper. The current yield was 79 %. F. J. B.

3142. Theoretical Potential of the Alkaline Earth Metals. G. Devoto. *Zeits. f. Elektrochem.* 34. *pp.* 326–327, *June*, 1928.

The author replies to a criticism of a previous publication of the same title [see Abstract 2005 (1928)]. It is shown that the criticism of Drossbach is unfounded, and that the values calculated for the theoretical potential of the alkaline earth metals are confirmed by still more recent determinations. F. J. B.

3143. Electrochemical Behaviour of Silicate Glasses. Part V. Electrical Properties of the Anode Layer. J. B. Ferguson, M. J. Mulligan and J. W. Rebbeck. *J. Phys. Chem.* 32. *pp.* 1018–1030, *July*, 1928.

The passage of an electric current through a sample of glass causes a change in the electrical properties of the sample if the composition of the glass is altered. The nature and the extent of some of these changes were investigated. It was found that when a glass sample is electrolysed at moderate temperatures with a difficultly soluble anode material, such as mercury, the current decreases as the electrolysis proceeded. The decrease was found to be due to the setting up of a counter e.m.f. and by an increase in the true resistance of the glass sample. At low voltages the counter e.m.f. may nearly equal the applied voltage, but at higher voltages the counter e.m.f. tends to assume a constant value. The minimum voltage required to give this nearly constant value increases as the electrolysis proceeds. The true resistance of a mercury-containing anode glass layer is many times that of the original glass. It changes with the temperature in accordance with the rule of Rasch and Hinrichsen. The smaller counter e.m.f.'s of constant values, noted when glass samples

were electrolysed with a soluble anode and a mercury kathode, were shown to be chemical in origin. The effect of current reversal on the electrical measurements was indicated for glass samples having a mercury-containing anode glass layer. Hopkinson's experiment on residual charge was repeated under new conditions. F. J. B.

3144. Direct Electrolytic Preparation of Potassium Permanganate. G. Rapin. *Comptes Rendus*, 187. *pp.* 112–114, *July* 9, 1928.

The electrolytic preparation of potassium permanganate from commercial silico-manganese is described. The use of a silico-manganese anode avoids the formation of an insulating coating on the anode, and it disintegrates regularly during the electrolysis. The electrolyte consists of potassium hydrate or carbonate in aqueous solution. The influence of concentration and temperature on the electrolysis is described. The method is stated to be applicable on the commercial scale. F. J. B.

3145. Influence of *p*H on the Electrolytic Deposit of Copper in Presence of Gelatine. C. Marie and (Miss) M. L. Claudel. *Comptes Rendus*, 187. *pp.* 170–171, *July* 17, 1928.

The addition of gelatine to a solution of copper sulphate brings on a surcharge with reference to Faraday's law in the deposit of the metal. Considering the influence of the concentration of H^+ ions on the properties of gelatine, the authors have tested whether the surcharge varied with the *p*H of the solutions of copper electrolysed. The results obtained show that as the *p*H increases from 0·88 to 3·2 the supercharge (expressed in grammes per 100 g. deposited in the comparison voltameter) increases from 2·86 to 5·58 and then decreases, as the *p*H is raised, to 3·57, which is the highest value which can so far be obtained. These results correspond with other characteristics of gelatine (viscosity, osmotic pressure, etc.), which pass through a maximum for values of *p*H comprised between 3·2 and 3·6. J. J. S.

3146. Effect of Colloids in the Electrodeposition of Silver. S. Wernick. *Faraday Soc., Trans.* 24. *pp.* 361–366, *July*, 1928.

The "silver numbers" of a number of colloids commonly used to reduce grain-size were determined. Carey Lea's sol was used. The precipitation method of Zsigmondy was found best for determining the silver number. Silver nitrate not being possible as a precipitant for all colloids, other precipitants were found to have approximately the same effect, but a minimum strength of precipitant is necessary. Silver deposits were obtained from a neutral silver nitrate solution containing the different colloids whose silver number had been determined, and microphotographs were taken. The number of crystals per unit area was determined, this being taken as a measure of the fineness of the deposit. With the exception of dextrin, there is a relationship between the silver number and the fineness of the deposit. The relationship is not sufficiently direct to enable a comparison to be made between two colloids having approximately similar effects, but it is quite sufficiently marked to enable "good" colloids to be differentiated from "bad." J. J. S.

3147. Electrodeposition of Iron-Nickel Alloys. S. Glasstone and T. E. Symes. *Faraday Soc., Trans.* 23. *pp.* 213–226, *May*, 1927, *and* 24. *pp.* 370–378, *July*, 1928.

Investigations are described of the compositions of the alloys deposited at

15° from well-buffered solutions of definite hydrogen-ion concentration containing various mixtures of ferrous and nickel sulphates at a series of current densities, and these were extended to higher temperatures. The the general conclusion that the relative tendencies for Fe and Ni to deposit in form of an alloy is independent of the H-ion concentration of the electrolyte has been confirmed. At higher temperatures the rate of increase of the proportion of Fe in the deposit with increasing c.d. is much less than at ordinary temperatures. The initial deposits and those containing the maximum amount of Fe contain less iron at 53° than do those got from the same solutions at 15°. The influence of dilution and stirring at 53° is similar to that observed at ordinary temperatures, but is not so marked on account of the increased rate of diffusion at the higher temperature. The effect of diffusion is almost negligible at 90°. There is a minimum iron content of the electrolyte from which the initially deposited alloy contains relatively less iron than does the electrolyte. This minimum decreases as the temperature rises. It appears that anions and kations do not have any appreciable influence on the relative tendency of iron and nickel to deposit from solutions containing *simple* ions of both metals.

J. J. S.

3148. Hardness of Electrodeposited Nickel. D. J. Macnaughtan and A. W. Hothersall. *Faraday Soc., Trans.* 24. *No.* 387–400, *July,* 1928.

The authors discuss various methods for the hardness testing of deposits, and conclude that the Brinell test is the best. The minimum thickness of deposits of various hardnesses that can be tested accurately by this method with a 1-mm. ball and 10-kg. load have been calculated on the basis of Moore's results. In various tests the results show that hard deposits with a finely crystalline structure ranging in hardness from Brinell numbers 280–315 were obtained from solutions containing nickel sulphate, ammonium sulphate, and potassium chloride, while soft deposits of larger grain-size ranging in hardness from Brinell numbers 155–170 were obtained from solutions containing nickel sulphate, boric acid and potassium chloride. The difference of hardness appeared to be due entirely to the presence of ammonium sulphate in the one solution and of boric acid in the other. The Brinell hardness of deposits obtained from solutions containing nickel sulphate, boric acid and potassium chloride was found to be increased from an average of 162 to 250 and 227 respectively by large additions to the solution of sodium sulphate and by replacement of the potassium chloride with an equivalent amount of sodium fluoride.

J. J. S.

3149. Diffusion of Electrolytes in Charged Gels. (Miss) Choucroun. *Comptes Rendus,* 187. *pp.* 296–297, *July* 30, 1928.

The author has recently shown that the polarisation of a charged membrane which separated two parts of a liquid couple is only appreciable when the more mobile of the associated ions has the same sign as the membrane [see Abstract 2869 (1928)]. It is now shown that the velocity of diffusion of an electrolyte in a neutral gel is only modified if the charge of the membrane has the same sign as the least mobile ion. The velocity is then always diminished. Experiments were made with potassium ferrocyanide and with neodymium sulphate in support of the theory.

F. J. B.